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Cylindrical Fits:

What Will Be The Next American Standard?

by

R. E. W. Harrison[1]

Chairman, Subcommittee on Tolerance Systems, Committee on Allowances and Tolerances for Cylindrical Parts and Limit Gages

Photo by Gerald Young
Courtesy Mechanical Engineering

IN 1925 an American Tentative Standard for Tolerances, Allowances, and Gages for Metai Fits was approved by the American Standards Association.

This standard gives eight different classes of fits between cylindrical parts, all in the basic hole system. Each fit involves a hole and a shaft of the same class, completely determined by the limits of each part; however, cross-combinations between a hole and a shaft of different classes are permissible.

Although the 1925 standard has been successfully used by a number of American firms, it has not been generally adopted. The system has been criticized for several reasons; for example, because of the absence of a standard shaft system; because the choice of fits seemed too limited; and because the step-ups in subranges of nominal diameters seemed too small.

Because of these criticisms, and also because the art of limit gaging was rapidly developing, in 1930 the committee which developed the 1925 standard was asked to review the situation and consider the question: Should the American Tentative Standard of 1925 be revised, and if so, should it be amplified or changed—or both?

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This question was particularly important because after the approval of the standard in 1925 work had been started on the development of an internationally unified system of cylindrical fits. In 1926, delegates of 18 countries met in New York to discuss more systematic international cooperation in matters of industrial standardization. This resulted in the organization of the International Standards Association, which is now a federation of twenty national standardizing bodies, including the American Standards Association. Cylindrical fits was one of the technical subjects discussed at this conference, and there was general agreement among the delegates that international unification of the national standard systems of fits seemed possible, in principle.

Consider ISA Proposal

One of the first projects undertaken by a technical committee under ISA auspices was that on Fits. The ASA received an invitation for American industry to take an active part in the work of this committee and laid this question before its committee on Allowances and Tolerances of Cylindrical Parts and Limit Gages at its reorganization meeting in December, 1930. The committee decided to give serious consideration to any proposals developed by the ISA committee, but did

not desire to be represented on it. The ASA committee and American industry in general have been kept informed about the progress of the ISA work by reports from the ASA staff. The article on pages 192-200 of this issue of INDUSTRIAL STANDARDIZATION is practically the final report on the recommendations of the ISA committee.

In carrying on its work, the ASA committee organized a Subcommittee on Tolerance Systems. R. E. W. Harrison is chairman, and Paul V. Miller, manager, Small Tool Division, Loft-Peirce Manufacturing Co., is secretary. This subcommittee held several meetings. In December, 1934, it asked D. R. Miller, Chief of the Gage Division, National Bureau of Standards, one of its members, to draft a set of tables of fits for the consideration of the committee. Complying with this request, Mr. Miller distributed copies of such a draft among the members.

The entire sectional committee met in New York, December, 1935, and decided to send a questionnaire to several branches of industry to determine their point of view on the proposed revision. To enable those canvassed to judge recent developments, it was decided that both Mr. Miller's tables and a report on the ISA system (see article below) should be mailed with the questionnaire.

A system of fits between cylindrical parts is one of the most important matters in the art of manufacturing, in the mechanical as well as in other industries. Therefore, the committee hopes that American industry will give special attention to the questionnaire, which is expected to go out early in September.

Is the International System of Fits Acceptable to American Industry?[1]

by
John Gaillard

Mechanical Engineer
American Standards Association

ASA Committee Asks Industry's Comments; Considers Revising 1925 American Tentative Standard

A STANDARD system of fits between cylindrical parts, intended to bring about international uniformity, has been completed for nominal sizes up to 500 millimeters (about 20 in.).[2] It was developed by a technical committee of the International Standards Association—a federation of the national standardizing bodies in twenty countries, including the American Standards Association.

Sixteen countries have already approved the ISA system:

Austria	Hungary
Belgium	Italy
Czechoslovakia	Japan
Denmark	Norway
Finland	Poland
France	Sweden
Germany	Switzerland
Holland	U.S.S.R.

Its adoption as the national standard in the United States and Great Britain would bring about world-wide unification of cylindrical fits.

The ASA committee on Allowances and Tolerances for Cylindrical Parts and Limit Gages is considering a revision of the American Tentative Standard for fits (B4a) adopted in 1925. It intends making a canvass of several branches of industry to find out, among other things, whether

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[1]This article, in a slightly abbreviated form, and without the tables, was published in *American Machinist*, July 15, 1936.

[2]For a description of an earlier tentative draft of the ISA system applying to nominal sizes up to 180 mm (about 7 in.) see "Should American Industry Adopt ISA Standard Fits?" (*American Machinist*, June 6, 1934, page 403; reprinted in INDUSTRIAL STANDARDIZATION, July, 1934).

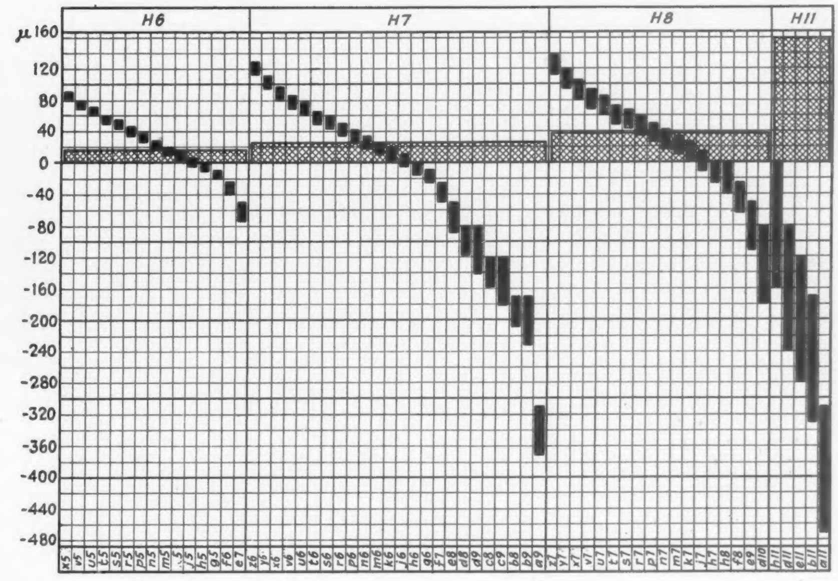


Fig. 1
Hole limits are cross hatched and shaft limits are shown in black in this selection of ISA fits using the Basic Hole system

the ISA system is deemed suitable for use in this country. For this reason, and because American manufacturers engaged in foreign trade may find references to ISA fits in specifications of sixteen foreign countries, the main features of the ISA system are presented here.

The extension of the system to nominal sizes up to 1600 mm (about 63 in.) is under way. For this larger range, formulas have been proposed to enable the designer to calculate the limits of the mating parts for different kinds of fits.

Brief History

The ISA system is the result of almost ten years' work by an ISA subcommittee of technical experts representing Germany, France, Sweden, Switzerland, and Czechoslovakia. This subcommittee tried to make the ISA fits interchangeable with those in the existing national systems whenever possible. When the work was started (1926), the most important national standards were the American, British, German, Sweden, and Swiss. Although neither American nor British industry has taken an active part in the development of the ISA system, Great Britain decided a few years ago to change its national standard reference temperature for gages from 62 to 68 F (standard also in the U.S.) for the sake of international uniformity, thus adopting one of the essential features of the ISA system.

The ISA committee agreed that limits for fits must be based on practical experience—not on theory. Formulas for tolerances and allowances, used as a framework, represent the experience gathered in workship practice. A special study was made of the wide clearance fits and the very tight press fits before they were finally adopted. A few of the latter are still tentative but as a whole the recommendations for the range up to 20 in. as indicated in the accompanying diagrams and tables, having reached their final shape.

Each American manufacturer will be able to decide whether the ISA system contains the fits required for his work—the most important consideration in determining whether the system is suitable to replace the American Standard of 1925. Whether the product involved is machine tools, automobiles, electric motors, telephone equipment, railway cars, agricultural machinery, or any other in which fits play a role, the revision of our national standard should be given due attention because of its great technical and economic significance.

Main Features of ISA System

(*a*). The *reference temperature* for limit gages is 20 C (68 F). This means that a gage must have its nominal size (equal to the limit of the work which it is intended to check) when the gage is at the temperature of 68 F. France and Great Britain have given up their previous national standard reference temperatures of zero C (32 F) and (62 F), respectively, for the sake of international uniformity. The reference temperature of 68 F is also specified in the American Standard of 1925. World-wide uniformity in this respect has thus been reached, with obvious benefit to gage makers and users. Until a few years ago, American gage manufacturers, in carrying out foreign orders, had to deal with three dif-

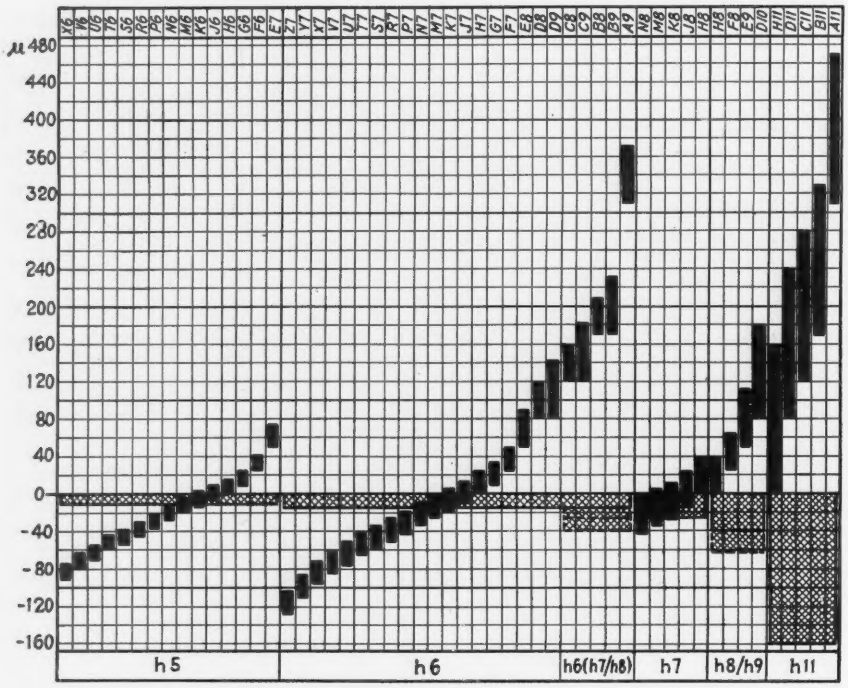


Fig. 2
Shaft limits are cross hatched and hole limits are shown in black in this selection of ISA fits using the Basic Shaft system

ferent reference temperatures (32, 62, and 68 F) and, incidentally, with different inch-millimeter conversion ratios. The latter difficulty has been removed by the adoption of the ratio 25.4 by the industries in Great Britain and the United States (American Standard Inch-Millimeter Conversion for Industrial Use, B48.1-1933), which paved the way for the recommendation of its general international adoption by the ISA.

(*b*). The nominal size line of the mating parts serves as the *reference line* from which the limits of workpieces and gages are located. This principle was followed also in the national standards existing prior to the ISA system, including the American Standard of 1925.

(*c*). The ISA system gives fits in the Basic Hole, as well as in the Basic Shaft system. In a Basic Hole system, a few holes whose low limit is the nominal size, are mated with a larger number of shafts whose limits are varied to produce the different fits. In a Basic Shaft system, a few shafts, with the nominal size as their high limit, are mated with a series of holes whose limits are chosen so as to get various fits.

Most of the national standards existing in 1926 gave fits in both systems, Basic Hole and Basic Shaft. The American Standard of 1925 gives the Basic Hole system exclusively and has been criticized on this score. For example, industries able to get satisfactory fits with cold-finished shafting without machining it, are interested in a Basic Shaft system. The ASA committee on fits has agreed in principle that such a system should be added when the 1925 standard is revised.

(*d*). The ISA tolerances are unilateral: the tolerance on a part is measured in *one* direction from its basic size, and not as a "plus and minus" variation, or bilateral tolerance. The unilateral system had been adopted in all national standards existing in 1926. In addition to the unilateral system, the British Standard of 1924 gives bilateral tolerances because these were originally adopted in the British Standard of 1906. However, the 1924 edition does not recommend bilateral tolerances for new work.

(*e*). The ISA system gives a series of standard shafts and a series of standard holes. These may be mated at will by the designer. The earlier national standards, except the British and the Dutch, gave definite fits (hole-shaft combinations) to serve as a guide. The American Standard of 1925 gives eight combinations ranging from a loose fit (Class 1) to a heavy force and shrink fit (Class 8).

With a view to traditional practice, the ISA committee has given Recommended ISA fits in the Basic Hole, and in the Basic Shaft system.

(*f*). In the ISA system, the manufacturing tolerance on a Go gage must lie within the limits of the workpiece but the gage may be used until it has worn a definite small amount past the Go limit of the work. A plus or minus variation is permitted from the nominal size of a Not Go

gage. These rules are in accordance with those of the major European standards existing in 1926, but differ from the principle adopted in the American Standard of 1925, as will be discussed in more detail later.

ISA Shafts and Holes—For each nominal size, the ISA system gives a series of shafts. Each shaft is designated by a symbol consisting of a lower case letter and a numeral, for example: d8. The letter indicates the minimum clearance or interference between the shaft and a hole having the nominal size. This value equals the distance between the reference line and the shaft limit lying nearest to it. All basic shafts—for which this distance is zero—are designated by the symbol *h*.

The numeral of the shaft symbol indicates the *grade* of the shaft which depends on the number of *tolerance units*[3] of the shaft tolerance. The ISA shafts intended for fits are divided into seven grades, 5 to 11. The corresponding tolerances on a one-inch shaft range from 9 to 130 microns, or about 3:5 to 51 tenths.

The ISA system also gives a series of standard holes for fits. The symbol of a hole consists of a capital letter followed by a numeral, such as R7. Basic holes have the letter H. The holes intended for fits are divided into five grades, 6 to 11.

It is easier, and hence less expensive, to keep a shaft between given limits, than a hole. Shafts of the finest grade (5) have tolerances that are 0.7 of those of the finest grade holes (grade 6).

Basic Hole System Primary—The ISA standard shafts were developed first. Their limits approach, as closely as is compatible with practical requirements, curves plotted for their tolerances and allowances. The hole tolerances were chosen next, in such a way that the fits available in the Basic Hole system may also be obtained in the Basic Shaft system.

The Basic Hole and the Basic Shaft system have thus been given equal consideration, but the latter has been adapted to the former. The Basic Hole system was made the primary system, because it is the one most commonly used.

Recommended ISA fits—The diagram, Fig. 1, shows a series of ISA fits in the Basic Hole system recommended for general use in the mechanical industry. Each of four basic holes (H6, H7, H8, and H11), indicated by double crosshatched bars, may be mated with any of the corresponding shafts. For example, Hole H6 may be mated with any of the shafts e7 to x7, inclusive. (NOTE: The scale of limits shown here is in microns).

[3]The concept "tolerance unit" was explained in the previous article (see footnote 2).

The tolerances shown in the diagram, Fig. 1, apply generally to nominal sizes from 30 to 50 mm (1.18 to 1.97 in.), inclusive. Where this subrange is divided again into two smaller ones, the values in Fig. 1 apply to the subrange 30 to 40 mm (1.18 to 1.57 in.).

The numerical values of the hole and shaft limits in the Basic Hole system are given in Tables 1 to 4. They have been obtained by converting the micron values to ten thousandths of an inch ("tenths"). Values up to 10 microns have been rounded to the nearest half tenth and higher values, to the nearest tenth.

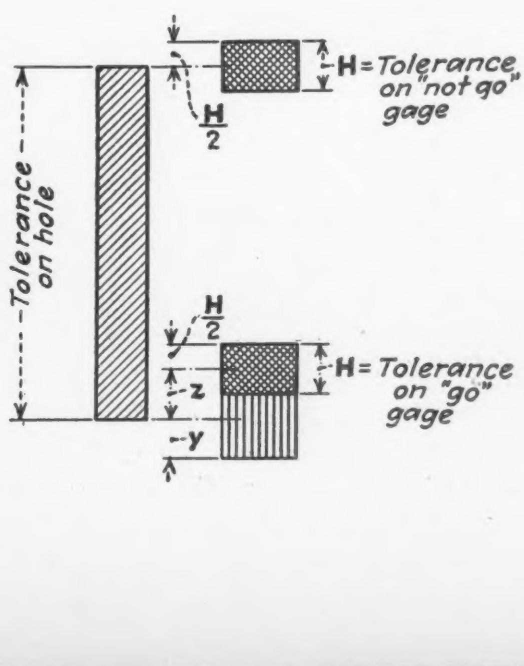
The problem of rounding will require further consideration. A tenth being equal to about 2½ microns, the conversion of microns to tenths causes a slight shift in the limits. Conversion to hundred-thousandths of an inch would avoid this, but five decimal places suggest an accuracy higher than required for most work.

The diagram, Fig. 2, gives the recommended ISA fits in the Basic Shaft system for the same nominal size range (or subrange) as given in Fig. 1 (limits in microns). Each of six basic shafts (h5 to h9, and h11) may be mated with the corresponding holes.

The numerical values of the limits in the Basic Shaft system are given in Tables 5 to 10. To save space, the fits between one of the shafts h6, h7, or h8, and one of the holes A9, B9, B8, C9, or C8, have been combined in Table 6, and the fits

Fig. 3

Bilateral tolerances used for ISA "Go" and "Not Go" gages for holes give the manufacturer two additional tolerance zones to allow for gage wear



between either of shafts h8 and h9, and one of the holes D10, E9, F8, and H8, in Table 9.

Nominal Size Ranges—The range of nominal sizes from 1 to 500 mm (0.04 to 19.69 in.), inclusive, is subdivided into a number of subranges, for each of which the tolerances and allowance remain constant.

The number of subranges is 13, 23, or 25, depending on the kind of holes or shafts. Tight press fits being very sensitive to variation in the interference of metal, the subranges are smaller for shafts *r* to *z*, and holes R to Z, intended to produce these fits, than for shafts *d* to *p*, and holes D to P, used for the regular clearance and transition fits. Similarly, for the very loose fits obtained with shafts *a*, *b*, and *c*, or holes A, B, and C, a finer subdivision of the nominal size range above 30 mm (1.18 in.) has been adopted with a view to the rapid increase in minimum clearance with size.

The 13 primary subranges (see, for example, Table 8) were obtained, up to 180 mm (7.09 in.) by taking over the subdivisions of earlier metric standards (1, 3, 6, 10, 18, 30, 50, 80, 120, and 180 mm), and above 180 mm by adopting a geometric progression according to the Preferred Numbers series: 250, 315, 400, and 500 mm.

In Tables 1 to 10, the subranges have been converted from millimeters to decimal inch values. Rounding to the nearest commonly used binary fraction (for example, 50 mm to 2 in., instead of to 1.97 in.) would cause a slight shift in the original subranges. A given nominal size might then fall within different subranges in the inch, and in the metric system, and accordingly get a different allowance and tolerances. Decimal inch fractions, used for many years exclusively for limits and tolerances, have recently become introduced also to indicate nominal sizes on drawings (Ford Motor Co.).

Extreme Work Limits—According to American Standard practice, the nominal manufacturing limits of a workpiece are its extreme permissible sizes. Variations in the sizes of the gages should not permit the work to exceed its own limits. Therefore, according to the American viewpoint, the manufacturing tolerances on gages must lie inside the tolerance on the work and a gage is not permitted to wear past a work limit. The latter condition applies primarily to Go gages, as Not Go gages practically do not wear.

In the ISA system, a Go gage is made to a basic gage size lying within the work tolerance at a distance *z* from the Go limit, see Fig. 3. The tolerance H on the Go gage is distributed equally on both sides of the basic gage size. The Go gage is permitted to wear a distance *y* past the Go limit of the work before being rejected as inaccurate. The basic size of a Not Go gage is the Not Go limit of the work. The tolerance H is a bilateral one again: a variation H/2 is permissible in each direction from the Not Go limit.

Therefore, in the ISA system, it may happen that workpieces are an amount *y* outside the Go limit or an amount H/2 outside the Not Go limit. The ISA system specifies that such work should be accepted. The manufacturer is thus given the benefit of the two extra tolerance zones when supplying parts to a purchaser.

The ISA report comprises tables giving the values of *y*, *z*, and H for each grade of hole or shaft. The extra tolerance zones resulting therefrom must be added to the nominal tolerances determined by the limits given in Tables 1 to 10. This has not been done here to avoid complicating the tables which are meant to give a general picture of the ISA fits. The gage tolerance, being a fraction of the work tolerance, does not essentially affect the nature of a fit. Yet, this should be kept in mind: When the work remains within the *nominal* ISA limits shown in the accompanying tables, its acceptance is certain, but the manufacturer foregoes the benefit of the extra tolerance zones. To use these may be important from the viewpoint of production cost.

Cylindrical Fits Recommended by the ISA

In principle standard holes and standard shafts in the ISA system, described in this article, may be combined at will.

However, to give the designer some guidance in the selection of suitable fits, the ISA committee has developed a series of hole-shaft combinations covering the most common requirements in different branches of industry.

These Recommended ISA Fits, in the Basic Hole system, as well as in the Basic Shaft system, are given in the Tables reproduced on pages 197 to 200, inclusive. The limits are listed in ten-thousandths of an inch.

In special cases where none of the recommended ISA fits suits the manufacturer's problem, he still may be able to find some other combination between a standard ISA hole and a standard ISA shaft that is satisfactory. However, adherence to the Recommended ISA Fits shown in these tables tends to keep down the total number of different fits used by industry as a whole, and hence the total variety of tools and gages required to produce these fits.

Recommended ISA Fits, Basic Hole System

Table 1

Nominal Size (inches) from	to *	Hole H6 basic to +	e7 −	e7 −	f6 −	f6 −	g5 −	g5 −	h5 0	h5 −	j5 +	j5 −	k5 +	k5 +	m5 +	m5 +	n5 +	n5 +	p5 +	p5 +	r5 +	r5 +	s5 +	s5 +	t5 +	t5 +	u5 +	u5 +	(v5)* +	(v5)* +	x5* +	x5* +
.04	.12	3	6	9	3	6	1	3	0	2	1.5	.5	X	X	3	1	4	2.5	6	3.5	7	5	8	6	X	X	9	7	X	X	11	9
.12	.24	3	8	13	4	7	1.5	3.5	0	2	1.5	.5	X	X	3.5	1.5	5	3	7	5	8	6	9	8	X	X	11	9	X	X	13	11
.24	.39	3.5	10	16	5	9	2	4	0	2.5	1.5	1	3	.5	5	2.5	6	4	8	6	10	7	11	9	X	X	13	11	X	X	16	13
.39 .55	.55 .71	4	13	20	6	11	2.5	6	0	3	2	1	3.5	.5	6	3	8	5	10	7	12	9	14	11	X	X	16	13	X 19	X 15	19 21	16 18
.71 .94	.94 1.18	5	16	24	8	13	3	6	0	3.5	2	1.5	4	1	7	3	9	6	12	9	15	11	17	14	X 20	X 16	20 22	16 19	22 25	19 22	25 29	21 25
1.18 1.57	1.57 1.97	6	20	28	10	16	3.5	8	0	4	2.5	2	5	1	8	3.5	11	7	15	10	18	13	21	17	23 26	19 21	28 32	24 28	31 36	27 32	36 43	31 38
1.97 2.56	2.56 3.15	7	24	33	12	19	4	9	0	5	2.5	3	6	1	9	4	13	8	18	13	21 22	16 17	26 28	21 23	31 35	26 30	39 45	34 40	45 52	40 47	53 63	48 57
3.15 3.94	3.94 4.72	9	28	39	14	23	5	11	0	6	2.5	3.5	7	1	11	5	15	9	20	15	26 27	20 21	34 37	28 31	42 47	36 41	55 63	49 57	63 74	57 68	76 89	70 83
4.72 5.51 6.30	5.51 6.30 7.09	10	33	49	17	27	6	13	0	7	3	4	8	1	13	6	18	11	24	17	32 33 34	25 26 27	43 46 50	36 39 43	55 60 65	48 53 57	74 82 90	67 75 83	87 97 106	80 90 99	105 117 129	98 110 122
7.09 7.87 8.86	7.87 8.86 9.84	11	39	57	20	31	6	14	0	8	3	5	9	1.5	15	7	20	12	28	20	38 39 41	30 31 33	56 59 63	48 51 55	73 79 85	65 71 77	101 109 120	93 102 112	120 130 142	112 122 134	146 159 175	138 152 167
9.84 11.02	11.02 12.40	13	43	64	22	35	7	16	0	9	3	6	11	1.5	17	8	22	13	31	22	46 48	37 39	71 76	62 67	95 104	86 94	133 147	124 138	161 176	152 167	196 216	187 207
12.40 13.98	13.98 15.75	14	44	72	24	39	7	17	0	10	3	7	11	1.5	18	8	24	15	34	24	52 55	43 45	85 92	75 82	115 126	106 116	163 181	154 171	197 219	187 209	242 270	232 260
15.72 17.72	17.72 19.69	16	53	78	27	43	8	19	0	11	3	8	13	2	20	9	26	16	37	27	60 63	50 52	102 110	91 99	141 152	130 142	204 223	193 213	234 270	224 260	302 333	291 323

Shaft Limits (tenthousandths)

Table 2a

Nominal Size (inches) from	to *	Hole H7 basic to +	a9 −	a9 −	b9 −	b9 −	b8 −	b8 −	c9 −	c9 −	c8 −	c8 −	d9 −	d9 −	d8 −	d8 −	e8 −	e8 −	f7 −	f7 −	g6 −	g6 −	h6 0	h6 −	j6 +	j6 −	k6 +	k6 +	m6 +	m6 +
.04	.12	3.5	106	116	55	65	55	61	24	33	24	29	8	18	8	13	6	11	3	6	1	4	0	3	2.5	5	X	X	3.5	1
.12	.24	5	106	118	55	67	55	62	28	39	28	35	12	24	12	19	8	15	4	9	1.5	5	0	3	3	.5	X	X	5	1.5
.24	.39	6	110	124	59	73	59	68	31	46	31	40	16	30	16	24	10	19	5	11	2	6	0	3.5	3	1	4	.5	6	2.5
.39	.71	7	114	131	59	76	59	70	37	54	37	48	20	37	20	30	13	25	6	13	2.5	7	0	4	3	1	5	.5	7	3
.71	1.18	8	118	139	63	83	63	76	43	64	43	56	26	46	26	39	16	29	8	16	3	8	0	5	3.5	1.5	6	1	8	3
1.18 1.57	1.57 1.97	10	122 126	146 150	67 71	91 95	67 71	82 86	47 51	72 76	47 51	63 67	31	56	31	47	20	35	10	20	3.5	10	0	6	4	2	7	1	10	3.5
1.97 2.56	2.56 3.15	12	134 142	163 171	75 79	104 108	75 79	93 97	55 59	84 88	55 59	73 77	39	69	39	57	24	42	12	24	4	11	0	7	5	3	8	1	12	4
3.15 3.94	3.94 4.72	14	150 161	184 196	87 94	121 129	87 94	108 116	67 71	101 105	67 71	88 92	47	81	47	69	28	50	14	28	5	13	0	9	5	3.5	10	1	14	5
4.72 5.51 6.30	5.51 6.30 7.09	16	181 205 228	220 244 268	102 110 122	142 150 161	102 110 122	127 135 147	79 83 91	118 122 130	79 83 91	104 108 115	57	96	57	82	33	58	17	33	6	15	0	10	6	4	11	1	16	6
7.09 7.87 8.86	7.87 8.86 9.84	18	260 291 323	305 337 368	134 150 165	179 195 211	134 150 165	162 178 194	94 102 110	140 148 156	94 102 110	123 131 139	67	112	67	95	39	68	20	38	6	17	0	11	6	5	13	1.5	18	7
9.84 11.02	11.02 12.40	20	362 413	413 465	189 213	240 264	189 213	221 244	118 130	169 181	118 130	150 162	75	126	75	107	43	75	22	43	7	19	0	13	6	6	14	1.5	20	8
12.40 13.98	13.98 15.75	22	472 532	538 587	236 268	291 323	236 268	271 303	142 157	197 213	142 157	177 193	83	138	83	118	49	84	24	47	7	21	0	14	7	7	16	1.5	22	8
15.75 17.72	17.72 19.69	25	591 650	652 711	299 331	360 392	299 331	337 369	173 189	234 250	173 189	211 227	91	152	91	129	53	91	27	52	8	24	0	16	8	8	18	2	25	9

Shaft Limits (tenthousandths)

Table 2b

Nominal Size (inches) from	to ●	Hole H 7 basic to +	n6 +	n6 +	p6 +	p6 +	r6 +	r6 +	s6 +	s6 +	t6 +	t6 +	u6 +	u6 +	(v6)* +	(v6)* +	x6 * +	x6 * +	(y6)* +	(y6)* +	z6 * +	z6 * +
.04	.12	3.5	5	2.5	6	3.5	7	5	9	6			10	7			11	9			14	11
.12	.24	5	6	3	8	5	9	6	11	7			12	9			14	11			17	14
.24	.39	6	7	4	9	6	11	7	13	9			15	11			17	13			20	17
.39	.55	7	9	5	11	7	13	9	15	11			17	13			20	16			24	20
.55	.71														20	15	22	18			28	24
.71	.94	8	11	6	14	9	16	11	19	14			21	16	24	19	26	21	30	25	34	29
.94	1.18										21	16	24	19	27	22	30	25	35	30	38	35
1.18	1.57	10	13	7	17	10	20	13	23	17	25	19	30	24	33	27	38	31	45	37	50	44
1.57	1.97										28	21	34	28	38	32	44	38	51	45	60	54
1.97	2.56	12	15	8	20	13	24	16	28	21	33	26	42	34	48	40	56	48	64	57	75	68
2.56	3.15						24	17	31	23	37	30	48	40	55	47	65	57	76	69	90	83
3.15	3.94	14	18	9	23	15	29	20	37	28	44	36	57	49	66	57	79	70	98	84	110	102
3.94	4.72						30	21	40	31	46	41	65	57	76	68	91	83	109	100	131	122
4.72	5.51	16	20	11	27	17	35	25	46	36	58	48	77	67	89	80	107	98	128	118	154	144
5.51	6.30						35	26	49	39	63	53	85	75	100	90	120	110	144	134	173	163
6.30	7.09						37	27	52	43	67	57	93	83	109	99	132	122	159	150	193	183
7.09	7.87	18	24	12	31	20	42	30	59	48	77	65	104	92	123	112	149	138	179	167	216	205
7.87	8.86						43	31	63	51	82	71	113	102	133	122	163	152	196	185	237	226
8.86	9.84						44	32	67	55	89	77	123	118	145	134	179	167	216	205	263	252
9.84	11.02	20	26	13	35	22	50	37	75	62	98	86	137	124	164	152	200	187	241	228	292	280
11.02	12.40						51	39	80	67	107	94	150	138	180	167	219	207	269	256	324	311
12.40	13.98	22	29	15	39	24	57	43	89	75	120	106	168	154	201	187	246	232	302	287	369	354
13.98	15.75						59	45	96	82	130	116	185	171	223	209	274	260	337	323	408	394
15.75	17.72	25	31	16	43	27	65	53	107	91	146	130	209	193	250	234	307	291	378	362	449	433
17.72	19.69						68	52	115	99	157	142	228	213	276	260	339	323	409	394	508	492

Shaft Limits (tenthousandths)

Table 4

Nominal Size (inches) from	to ●	Hole H 11 basic to +	a 11 −	a 11 −	b 11 −	b 11 −	c 11 −	c 11 −	d 11 −	d 11 −	h 11 0	h 11 −
.04	.12	24	106	130	55	79	24	47	8	31	0	24
.12	.24	30	106	136	55	85	28	57	12	41	0	30
.24	.39	35	110	146	59	94	31	67	16	51	0	35
.39	.71	43	114	157	59	102	37	81	20	63	0	43
.71	1.18	51	118	169	63	114	43	94	26	77	0	51
1.18	1.57	63	122	185	67	130	47	110	31	94	0	63
1.57	1.97		126	189	71	134	51	114				
1.97	2.56	75	134	209	75	150	55	130	39	114	0	75
2.56	3.15		142	217	79	154	59	134				
3.15	3.94	87	150	236	87	173	67	154	47	134	0	87
3.94	4.72		161	248	94	181	71	157				
4.72	5.51	98	181	280	102	201	79	177	57	156	0	98
5.51	6.30		205	303	110	209	83	181				
6.30	7.09		228	327	122	220	91	189				
7.09	7.87	114	260	374	134	248	94	209	67	181	0	114
7.87	8.86		291	406	150	264	102	217				
8.86	9.84		323	437	165	280	110	224				
9.84	11.02	126	362	488	189	315	118	244	75	201	0	126
11.02	12.40		413	539	213	339	130	256				
12.40	13.98	142	472	614	236	378	142	283	83	224	0	142
13.98	15.75		532	673	268	409	157	299				
15.75	17.72	157	591	748	299	457	173	331	91	248	0	157
17.72	19.69		650	807	331	488	189	346				

Shaft Limits (tenthousandths)

Table 3

Shaft Limits (tenthousandths)

Nominal Size (inches) from	to ●	Hole H8 basic to +	d 10 −	d 10 −	e9 −	e9 −	f8 −	f8 −	h8 0	h8 −	h7 0	h7 −	j7 +	j7 −	k7 +	k7 +	m7 +	m7 +	n7 +	n7 +
.04	.12	6	8	24	6	15	3	8	0	6	0	3.5	3	1					6	2.5
.12	.24	7	12	31	8	20	4	11	0	7	0	5	3.5	1					8	3
.24	.39	9	16	39	10	24	5	14	0	9	0	6	4	2	6	.5	8	2.5	10	4
.39	.55	11	20	47	13	30	6	17	0	11	0	7	5	2.5	7	.5	10	3	12	5
.55	.71																			
.71	.94	13	26	59	16	36	8	21	0	13	0	8	5	3	9	1	11	3	14	6
.94	1.18																			
1.18	1.57	15	31	71	20	44	10	25	0	15	0	10	6	4	11	1	13	3.5	17	7
1.57	1.97																			
1.97	2.56	18	39	87	24	53	12	30	0	18	0	12	7	5	13	1	16	4	20	8
2.56	3.15																			
3.15	3.94	21	47	102	28	63	14	35	0	21	0	14	8	6	15	1	19	5	23	9
3.94	4.72																			
4.72	5.51	25	57	120	33	73	17	42	0	25	0	16	9	7	17	1	22	6	26	11
5.51	6.30																			
6.30	7.09																			
7.09	7.87	28	67	140	39	86	20	48	0	28	0	18	10	8	20	1.5	25	7	30	12
7.87	8.86																			
8.86	9.84																			
9.84	11.02	32	75	157	43	94	22	54	0	32	0	20	10	10	22	1.5	28	8	34	13
11.02	12.40																			
12.40	13.98	35	83	173	49	104	24	59	0	35	0	22	11	11	24	1.5	31	8	37	15
13.98	15.75																			
15.75	17.72	38	91	189	53	114	27	65	0	38	0	25	12	13	27	2	34	9	41	16
17.72	19.69																			

Nominal Size (inches) from	to ●	p7 +	p7 +	r7 +	r7 +	s7 +	s7 +	t7 +	t7 +	u7 +	u7 +	(v7)* +	(v7)* +	x7 * +	x7 * +	(y7)* +	(y7)* +	z7 * +	z7 * +
.04	.12	7	3.5	8	5	9	6			11	7			12	9			15	11
.12	.24	9	5	11	6	12	7			14	9			16	11			19	14
.24	.39	12	6	13	7	15	9			17	11			19	13			22	17
.39	.55	14	7	16	9	18	11			20	13			23	16			27	20
.55	.71											22	15	25	18			31	24
.71	.94	17	9	19	11	22	14			24	16	27	19	30	21	33	25	37	29
.94	1.18							24	16	27	19	30	22	33	25	38	30	43	35
1.18	1.57	20	10	23	13	27	17	29	19	33	24	37	27	41	31	47	37	54	44
1.57	1.97							31	21	37	28	42	32	48	38	55	45	63	54
1.97	2.56	24	13	28	16	33	21	38	26	46	34	52	40	60	48	69	57	80	68
2.56	3.15			29	17	35	23	41	30	52	40	59	47	69	57	80	69	94	83
3.15	3.94	28	15	34	20	42	28	50	36	63	49	71	57	84	70	98	84	115	102
3.94	4.72			35	21	45	31	55	41	70	57	81	68	96	83	114	100	136	122
4.72	5.51	33	17	41	25	52	36	64	48	83	67	95	80	113	98	134	118	159	144
5.51	6.30			41	26	55	39	69	53	91	75	106	90	126	110	150	134	179	163
6.30	7.09			43	27	58	43	73	57	98	83	115	99	138	122	165	150	199	183
7.09	7.87	38	20	48	30	66	48	83	65	111	93	130	112	156	138	185	167	223	205
7.87	8.86			50	31	69	51	89	71	120	102	140	122	170	152	203	185	244	226
8.86	9.84			51	33	73	55	95	77	130	112	152	134	185	167	223	205	270	252
9.84	11.02	43	22	57	37	83	62	106	86	144	124	172	152	207	187	249	228	300	280
11.02	12.40			59	39	87	67	115	94	158	138	188	167	227	207	276	256	331	311
12.40	13.98	47	24	65	43	97	75	128	106	176	154	209	187	255	232	310	287	377	354
13.98	15.75			67	45	104	82	138	116	194	171	231	209	282	260	345	323	416	394
15.75	17.72	52	27	74	50	116	91	155	130	218	193	259	234	316	291	387	362	458	433
17.72	19.69			77	52	124	99	167	142	237	213	285	260	348	323	419	394	517	492

●Size subranges include high limiting figure, thus: "from above 0.04 inch to 0.12 inch, inclusive," etc.
*Shafts v, x, y, and z are tentative. Avoid using shafts v and y, if possible.

Table 5

Recommended ISA Fits, Basic Shaft System

•Size subranges include high limiting figure, thus: from above 0.04 inch to 0.12 inch, inclusive, etc.
*Shafts v, x, y, and z are tentative. Avoid using shafts v and y, if possible.

Recommended ISA Fits, Basic Shaft System

Table 5

Nominal Size (inches)		Shaft h5	Hole Limits (tenthousandths)																											
		basic to	E7		F6		G6		H6		J6		K6		M6		N6		P6		R6		S6		T6		U6		(V6)*		X6*	
from	to •	−	+	+	+	+	+	+	0	+	−	+	−	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
.04	.12	2	6	9	3	6	1	4	0	3	1.5	1	X	X	3	0	4	1.5	6	3	7	4	8	5	X	X	9	6	X	X	11	8
.12	.24	2	8	13	4	7	1.5	5	0	3	1.5	1.5	X	X	3.5	.5	5	2	7	3.5	8	5	9	6	X	X	11	8	X	X	13	10
.24	.39	2.5	10	16	5	9	2	6	0	3.5	1.5	2	3	1	5	1	6	3	8	5	10	6	11	8	X	X	13	10	X	X	16	12
.39	.55	3	13	20	6	11	2.5	7	0	4	2	2.5	3.5	1	6	1.5	8	3.5	10	6	12	8	14	10	X	X	16	12	X	X	19	15
.55	.71																								X	X			19	14	21	17
.71	.94	3.5	16	24	8	13	3	8	0	5	2	3	4	1	7	1.5	9	4	12	7	15	9	17	12	X	X	20	15	22	17	25	20
.94	1.18																								20	15	22	17	25	20	29	24
1.18	1.57	4	20	30	10	16	3.5	10	0	6	2.5	4	5	1	8	1.5	11	5	15	8	18	11	21	15	23	17	28	22	31	25	36	30
1.57	1.97																								26	19	32	26	36	30	43	36
1.97	2.56	5	24	35	12	19	4	11	0	7	2.5	5	6	1.5	9	2	13	6	18	10	21	14	26	19	31	24	39	32	45	38	53	46
2.56	3.15																				22	15	28	21	35	27	45	38	52	45	63	55
3.15	3.94	6	28	42	14	23	5	13	0	9	2.5	6	7	1.5	11	2.5	15	6	20	12	26	17	34	25	42	33	55	46	63	55	76	67
3.94	4.72																				27	19	37	28	47	38	63	54	74	65	89	80
4.72	5.51	7	33	49	17	27	6	15	0	10	3	7	8	1.5	13	3	18	8	24	14	32	22	43	33	55	45	74	64	87	77	105	95
5.51	6.30																				33	23	46	37	60	50	82	72	97	87	117	107
6.30	7.09																				34	24	50	40	65	55	90	80	106	96	129	119
7.09	7.87	8	39	57	20	31	6	17	0	11	3	9	9	2	15	3	20	9	28	16	38	27	56	44	73	62	101	89	120	108	146	134
7.87	8.86																				39	28	59	48	79	67	109	98	130	119	159	148
8.86	9.84																				41	30	63	52	85	74	120	108	142	130	175	164
9.84	11.02	9	48	64	22	35	7	19	0	13	3	10	11	2	16	3.5	22	10	31	19	46	33	71	59	95	82	133	120	161	148	196	183
11.02	12.40																				48	35	76	63	104	91	147	134	176	164	216	203
12.40	13.98	10	49	72	24	39	7	21	0	14	3	11	11	3	18	4	24	10	34	20	52	38	85	70	116	101	168	149	197	183	242	228
13.98	15.75																				55	41	92	78	126	111	181	167	219	204	270	256
15.75	17.72	11	53	78	27	43	8	24	0	16	3	13	13	3	20	4	26	11	37	22	60	44	102	86	141	125	204	188	245	229	302	286
17.72	19.69																				63	47	110	94	152	137	223	207	270	255	333	318

Table 6

Nominal Size (inches)		Shaft			Hole Limits (tenthousandths)									
		h6 basic to	h7 basic to	h8 basic to	A9		B9		B8		C9		C8	
from	to •	−	−	−	+	+	+	+	+	+	+	+	+	+
.04	.12	3	3.5	6	106	116	55	65	55	61	24	33	24	29
.12	.24	3	5	7	106	118	55	67	55	62	28	39	28	35
.24	.39	3.5	6	9	110	124	59	73	59	68	31	46	31	40
.39	.71°	4	7	11	114	127	59	76	59	70	37	54	37	48
.71	1.18	5	8	13	118	139	63	83	63	76	43	64	43	56
1.18	1.57	6	10	15	122	146	67	91	67	82	47	72	47	63
1.57	1.97				126	155	71	95	71	86	51	76	51	67
1.97	2.56	7	12	18	134	163	75	104	75	93	55	84	55	73
2.56	3.15				142	171	79	108	79	97	59	88	59	77
3.15	3.94	9	14	21	150	184	87	121	87	108	67	101	67	88
3.94	4.72				161	196	94	129	94	116	71	105	71	92
4.72	5.51	10	16	25	181	220	102	142	102	127	79	118	79	104
5.51	6.30				205	244	110	150	110	135	83	122	83	107
6.30	7.09				228	268	122	161	122	147	91	130	91	115
7.09	7.87	11	18	28	260	305	134	179	134	162	94	140	94	123
7.87	8.86				291	337	150	195	150	178	102	148	102	131
8.86	9.84				323	368	165	211	165	194	110	156	110	139
9.84	11.02	13	20	32	362	413	189	240	189	221	118	169	118	150
11.02	12.40				413	465	213	264	213	244	130	181	130	162
12.40	13.98	14	22	35	472	528	236	291	236	271	142	197	142	177
13.98	15.75				532	587	268	323	268	303	157	213	157	193
15.75	17.72	16	25	38	591	652	299	360	299	337	173	234	173	211
17.72	19.69				650	730	331	392	331	369	189	250	189	227

Table 7a

Nominal Size (inches)		Shaft h6	Hole Limits (tenthousandths)																					
		basic to	D9		D8		E8		F7		G7		H7		J7		K7		M7		N7		P7	
from	to •	−	+	+	+	+	+	+	+	+	+	+	0	+	−	+	−	+	−	0	−	−	−	−
.04	.12	3	8	18	8	13	6	11	3	6	1	5	0	3.5	2.5	1	X	X	3.5	0	5	1.5	6	3
.12	.24	3	12	24	12	19	8	15	4	9	1.5	6	0	5	3	2	X	X	5	0	6	1.5	8	3
.24	.39	3.5	16	30	16	24	10	19	5	11	2	8	0	6	3	3	4	2	6	0	7	1.5	9	3.5
.39	.71	4	20	37	20	30	13	23	6	13	2.5	9	0	7	3	4	5	2.5	7	0	9	2	11	4
.71	1.18	5	26	46	26	39	16	29	8	16	3	11	0	8	3.5	5	6	2.5	8	0	11	3	14	6
1.18	1.97	6	31	56	31	47	20	35	10	20	3.5	13	0	10	4	6	7	3	10	0	13	3	17	7
1.97	3.15	7	39	69	39	57	24	42	12	24	4	16	0	12	5	7	8	3.5	12	0	15	3.5	20	8
3.15	4.72	9	47	81	47	69	28	50	14	28	5	19	0	14	5	9	10	4	14	0	18	4	23	9
4.72	7.09	10	57	96	57	82	33	58	17	33	6	21	0	16	6	10	11	5	16	0	20	5	27	11
7.09	9.84	11	67	112	67	95	39	68	20	38	6	24	0	18	6	12	13	5	18	0	24	6	31	13
9.84	12.40	13	75	126	75	107	43	75	22	43	7	27	0	20	6	14	14	6	20	0	26	6	35	14
12.40	15.75	14	83	138	83	118	49	84	24	47	7	30	0	22	7	15	16	7	22	0	29	6	39	16
15.75	19.69	16	91	152	91	129	53	91	27	53	8	33	0	25	8	17	18	7	25	0	31	7	43	18

Table 7b

Nominal Size (inches) from	to ●	Shaft h6 basic to −	Hole Limits (tenthousandths) R7 −	R7 −	S7 −	S7 −	T7 −	T7 −	U7 −	U7 −	(V7)* −	(V7)* −	X7* −	X7* −	(Y7)* −	(Y7)* −	Z7* −	Z7* −
.04	.12	3	7	4	9	5			10	6			11	8			14	10
.12	.24	3	9	4	11	6			12	7			14	9			17	12
.24	.39	3.5	11	5	13	7			15	9			17	11			20	14
.39	.55	4	13	6	15	8			17	10			20	13			24	17
.55	.71										20	13	22	15			28	21
.71	.94	5	16	8	19	11			21	13	24	15	26	18	30	22	34	26
.94	1.18						21	13	24	16	27	19	30	22	35	26	40	31
1.18	1.57	6	20	10	23	13	25	15	30	20	33	23	38	28	43	33	50	41
1.57	1.97						28	18	34	24	38	28	44	35	51	41	60	50
1.97	2.56	7	24	12	28	17	33	22	42	30	48	36	56	44	64	52	75	63
2.56	3.15		24	13	31	19	37	25	48	36	55	43	65	53	76	64	90	78
3.15	3.94	9	29	15	37	23	44	31	57	44	66	52	79	65	93	79	110	96
3.94	4.72		30	16	40	26	50	36	65	52	76	63	91	74	109	95	131	117
4.72	5.51	10	35	19	46	30	58	42	77	61	89	74	107	92	128	112	154	138
5.51	6.30		35	20	49	33	63	47	85	69	100	84	120	104	144	128	173	157
6.30	7.09		37	21	52	37	67	52	93	77	109	93	132	116	159	144	193	177
7.09	7.87	11	42	24	59	41	77	59	104	86	123	105	149	131	179	160	216	198
7.87	8.86		43	25	63	44	82	64	113	95	133	115	163	145	196	178	238	220
8.86	9.84		44	26	67	48	89	70	123	105	145	127	179	161	216	198	263	245
9.84	11.02	13	50	29	75	54	98	78	137	116	164	144	200	179	241	220	292	272
11.02	12.40		51	31	80	59	107	87	150	130	180	159	219	199	269	248	324	303
12.40	13.98	14	57	34	89	67	120	97	168	145	201	179	246	224	302	279	369	346
13.98	15.75		59	37	96	74	130	107	185	163	223	200	274	252	337	315	408	385
15.75	17.72	16	65	41	107	82	146	121	209	184	250	225	307	282	378	353	449	424
17.72	19.69		68	43	115	90	157	133	228	204	276	251	339	314	409	385	508	483

Table 8

Nominal Size (inches) from	to ●	Shaft h7 basic to −	Hole Limits (tenthousandths) H8 0	H8 +	J8 −	J8 +	K8 −	K8 +	M8 −	M8 +	N8 −	N8 −
.04	.12	3.5	0	6	3	3					6	.5
12	.24	5	0	7	3.5	3.5					8	1
.24	.39	6	0	9	4	5	6	2.5	8	.5	10	1
.39	.71	7	0	11	5	6	7	3	10	1	12	1
.71	1.18	8	0	13	5	8	9	4	11	1.5	14	1
1.18	1.97	10	0	15	6	9	11	5	13	2	17	1
1.97	3.15	12	0	18	7	11	13	6	16	2	20	1.5
3.15	4.72	14	0	21	8	13	15	6	19	2.5	23	1.5
4.72	7.09	16	0	25	9	16	17	8	22	3	26	1.5
7.09	9.84	18	0	28	10	19	20	9	25	3.5	30	2
9.84	12.40	20	0	32	10	22	22	10	28	3.5	34	2
12.40	15.75	22	0	35	11	24	24	11	31	4	37	2
15.75	19.69	25	0	38	12	26	27	11	34	4	41	2.5

Table 9

Nominal Size (inches) from	to ●	Shaft h8 basic to −	Shaft h9 basic to −	Hole Limits (tenthousandths) D10 +	D10 +	E9 +	E9 +	F8 +	F8 +	H8 0	H8 +
.04	.12	6	10	8	24	6	15	3	8	0	6
12	.24	7	12	12	31	8	20	4	11	0	7
.24	.39	9	14	16	39	10	24	5	14	0	9
.39	.71	11	17	20	47	13	30	6	17	0	11
.71	1.18	13	20	26	59	16	36	8	21	0	13
1.18	1.97	15	24	31	71	20	44	10	25	0	15
1.97	3.15	18	29	39	87	24	53	12	30	0	18
3.15	4.72	21	34	47	102	28	63	14	35	0	21
4.72	7.09	25	39	57	120	33	73	17	42	0	25
7.09	9.84	28	45	67	140	39	85	20	48	0	28
9.84	12.40	32	51	75	157	43	94	22	54	0	32
12.40	15.75	35	58	83	173	49	104	24	59	0	35
15.75	19.69	38	61	91	189	58	114	27	65	0	38

Table 10

Nominal Size (inches) from	to ●	Shaft h11 basic to −	Hole Limits (tenthousandths) A11 +	A11 +	B11 +	B11 +	C11 +	C11 +	D11 +	D11 +	H11 0	H11 +
.04	.12	24	106	130	55	79	24	47	8	31	0	24
.12	.24	30	106	136	55	85	28	57	12	41	0	30
.24	.39	35	110	146	59	94	31	67	16	51	0	35
.39	.71	41	114	157	59	102	37	81	20	63	0	41
.71	1.18	51	118	169	63	114	43	94	26	77	0	51
1.18	1.57	63	122	185	67	130	47	110	31	94	0	63
1.57	1.97		126	189	71	134	51	114				
1.97	2.56	75	134	209	75	150	55	130	39	114	0	75
2.56	3.15		142	217	79	154	59	134				
3.15	3.94	87	150	236	87	173	67	154	47	134	0	87
3.94	4.72		161	248	94	181	71	157				
4.72	5.51	98	181	280	102	201	79	177	57	156	0	98
5.51	6.30		205	303	110	209	83	181				
6.30	7.09		228	327	122	220	91	189				
7.09	7.87	114	260	374	134	248	94	209	67	181	0	114
7.87	8.86		291	406	150	264	102	217				
8.86	9.84		323	437	165	280	110	224				
9.84	11.02	126	362	488	189	315	118	244	75	201	0	126
11.02	12.40		413	539	213	339	130	256				
12.40	13.98	142	472	614	236	378	142	283	83	224	0	142
13.98	15.75		532	678	268	409	157	299				
15.75	17.72	157	591	748	299	457	173	331	91	248	0	157
17.72	19.69		650	807	331	488	189	346				

●Size subranges include high limiting figure, thus: "from above 0.04 inch to 0.12 inch, inclusive," etc.
*Holes V, X, Y, and Z are tentative. Avoid using holes V and Y, if possible.

Study Strength of Mortar Cubes; May Use Results in Standard

A study has been made by the cement reference laboratory, maintained jointly by the American Society for Testing Materials and the National Bureau of Standards, of the variations in compressive strength of 2-inch mortar cubes resulting from various departures from planeness in the surfaces of bearing blocks, reports an article in the July issue of the *Technical News Bulletin*, published by the National Bureau of Standards.

It is planned to use the information resulting from the tests when the requirements for molds and bearing blocks now given in the A.S.T.M. Tentative Method of Test for Compressive Strength of Portland Cement Mortars[1] are reconsidered, the article says.

The cubes were tested under the following seven conditions of bearing surface of top and bottom bearing blocks: (1) plane; (2, 3, 4) concave, with spherical curvatures such that the mid-ordinates, measured from a circular plane 2 inches in diameter, were respectively 0.001, 0.002, and 0.004 inch; (5, 6, 7) convex, spherical, with mid-ordinates the same as for the concave faces. Under each of the seven loading conditions, 24 cubes were tested at each of the ages of 1, 3, 7, and 28 days.

It appears that the present tolerances of the C 109-34 T specifications are not too stringent, and that departures from planeness of bearing blocks, in excess of these tolerances, but within the limits of surfaces of some blocks and molds which have been observed, may be responsible for relatively important variations in the strength determinations on 2-inch cubes.

Use International Standard Values In Compiling Copper Wire Tables

The circular of the National Bureau of Standards giving copper wire tables, which has not been available for several years, is now being reprinted. Copies may soon be purchased from the Government Printing Office.

The tables in Circular 31, Copper Wire Tables, are in terms of the international standard values for the electrical resistivity, temperature coefficient, and density of copper, adopted in 1913 by the International Electrotechnical Commission and based on research in the Bureau's laboratories, according to the Bureau's announcement. The history of the standard values is discussed in the circular.

The circular also gives considerable attention to wire gages, including a brief history of their development, trend of practice at the time the circular was prepared, and a detailed consideration of the American wire gage.

The tables are comprehensive, the Bureau's announcement says, and include, besides tables giving the relations of resistance, length, and mass for standard sizes, tables of standard resistivities and temperature coefficients, wire gages, cables, and aluminum wire. The data are duplicated in English and metric units.

Appendices include the expression of the various kinds of resistivity and units thereof; calculation of the constant connecting the change of resistivity with the temperature, from the known law of proportionality between temperature coefficient and conductivity; data on the density of copper; calculation of the resistance and mass of cables; and the international standard of resistance for copper.

A.S.T.M. Changes Tests For Coal and Coke

A revision of the Standard Methods of Laboratory Sampling and Analysis of Coal and Coke, to include certain low-temperature cokes, green cokes, chars, anthracites, and semi-anthracites, has been proposed for publication as tentative standard by the American Society for Testing Materials' Committee on Coal and Coke.

These fuels, it has been found, should be given the preliminary heat treatment to prevent too rapid evolution of moisture and gases, which the original standard prescribes for subbituminous coal, lignite, and peat. This heat treatment is part of the modified procedure for the determination of volatile matter given in the standard. The proposed revision also includes more detailed instructions for this modified method.

The original standard was approved by the American Standards Association in 1933, and is known as American Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (A.S.T.M. D 271-33; ASA K18-1933).

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[1]A.S.T.M. C 109-34 T.

Confusion in Motor Regulations Makes Standardization Essential

Safety Rules Proposed by ICC Bureau of Motor Carriers, and Work of ASA Committee on Standard Inspection Requirements, Aim at National Uniformity

Manufacturers and Operators Will Benefit, Says Motor Company Official

TRUCK manufacturers have a vital interest in the regulations proposed by the Motor Carrier Bureau of the Interstate Commerce Commission (see page 00) said Pierre Schon, Transportation Engineer, General Motors Truck Company, during the Transportation Conference at Detroit in March. Forty-nine varieties of safety and equipment regulations enacted by the 48 states and the District of Columbia make for the worst type of confusion, he said. Uniformity of regulations will be highly beneficial to the trucking industry, regardless of what the regulations are, and will help to solve some of the truck engineering and operating problems, in Mr. Schon's opinion.

Mr. Schon analyzed some of the problems which face the truck manufacturer when there is no uniformity of regulations for equipment or operation. He says:

"Standardization of equipment requirements for motor vehicles is highly desirable from every standpoint. A recent analysis exposed the wide varieties of regulations affecting the design and installation of various equipment items."

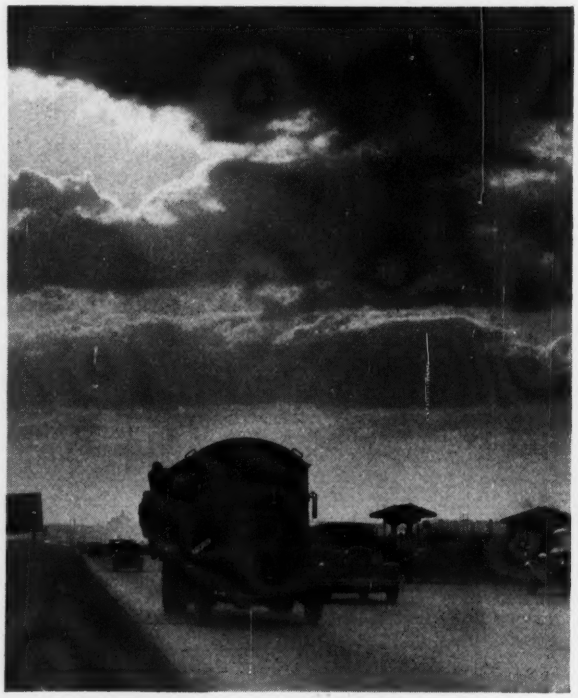
Mr. Schon submitted a resume of existing regulations, with comments, as follows:

Resume of Regulations

Brake Laws — The manufacturer's brake equipment problems are growing more complicated every year, due to different specifications for equipment on commercial vehicles. There is no uniformity in the brake laws enacted in the various states, and this has created a difficult problem for the designing engineers and the operators. For example: In 24 states the laws specify a stopping distance ability, based on the speed at which the vehicle is traveling.

At 20 miles per hour, these stopping distances vary from 30 up to 50 feet; in other words, a vehicle may meet with the Michigan law, requiring a stopping distance of 40 feet, but in Illinois this vehicle must be capable of stopping within a distance of 30 feet when traveling at 20 miles per hour. Power-brake equipment specifications are also very complicated and great care must be exercised in manufacturing plants to comply with this great variety of restrictions, as it is difficult

Charles Phelps Cushing



ASA Cooperates on Proposed ICC Safety Rules for Trucks, Busses

THE first step in setting up national safety regulations for the operation of motor trucks and busses in interstate commerce was taken in July by the Bureau of Motor Carriers of the Interstate Commerce Commission. Authorized by the Motor Carrier Act of 1935 to prepare regulations for busses and trucks used in interstate commerce, the Bureau prepared and issued, for comment and criticism, a booklet of Proposed Safety Regulations. Comments received by the Bureau on the proposed regulations will be considered, and changes which seem desirable will be made in the recommendations before they are submitted to the Interstate Commerce Commission for final action.

The American Standards Association was one of the organizations consulted by the Bureau during preparation of the recommendations. Meetings were held by a special subcommittee of the Sectional Committee of Inspection Requirements for Motor Vehicles (D7) operating under the procedure of the ASA. Recommendations for safe equipment and operation of motor vehicles, agreed upon by this committee, were sent to the Bureau of Motor Carriers for its consideration. Many of these recommendations are included in the proposed regulations.

In addition to the recommendations for parts and accessories necessary for safe operation, the proposed regulations include sections on qualifications of drivers, and driving of motor vehicles.

In his foreword to the recommendations, John L. Rogers, director of the Bureau, says:

"While these rules and regulations are drawn for application to common and contract motor carriers, because special administrative problems are involved in their application to private motor carriers, we desire also the views of interested parties as to the propriety of making like rules and regulations applicable to private motor carriers."

The article on page 202 analyzes some of the difficulties which these regulations are intended to reduce. Already part of the problem as outlined by Mr. Schon has been taken care of through work of committees under the procedure of the American Standards Association. The American Standard Specifications and Methods of Test for Safety Glass for Glazing Motor Vehicles Operating on Land Highways, for instance, takes care of the situation as analyzed by Mr. Schon in the section on "Safety Glass."

The Sectional Committee on Inspection Requirements of Motor Vehicles (D7), operating under the administrative leadership of the American Association of Motor Vehicle Administrators and the National Bureau of Casualty and Surety Underwriters, hopes that its work will result in eliminating much of the confusion now existing in connection with safety equipment and operation of motor vehicles. This committee is working on performance requirements and methods of testing safety equipment of all types of motor vehicles.

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to find two neighboring states with a similarity of regulations.

Safety Glass—27 states have enacted safety glass laws and here again we find a considerable variation in specifications as to location of safety glass, the type approved by the Commissioners, and what classes of vehicles actually require safety glass according to the legal prescriptions.

Flares and Fusees—29 states have enacted regulations requiring vehicles to carry flares and fusees, oil-burning torches and flags. The regulations in 25 states require that a vehicle must carry anywhere from one up to three flares and fusees. Seven states require oil-burning torches ranging from one to three per vehicle or vehicle combination. Flags must be carried according to the law in 10 states and all of this equipment—flares, fusees, torches and flags—is subject to approval by the Commissioner in 10 of the 29 states.

There is no uniformity either in the specifications, color, or the number of these warning signals which the operator must provide on his vehicle.

The driver also must be thoroughly familiar with the variety of laws specifying the distance these warning signals have to be placed ahead and at the rear of disabled vehicles. In South Carolina, for instance, the law requires the driver to place these warning signals 20 feet ahead and 20 feet to the rear, while in the other states distances are prescribed as follows:

50, 75, 100, 125, 150, 200, 300 ft, and in Kansas the driver must walk 500 ft to the rear of the

vehicle and 500 ft to the front and properly place his warning signals on the highway.

Clearance Lights—Clearance lights are required by all states, but here we have regulations requiring almost all the colors of the rainbow: Amber, blue, green, purple, red, white, yellow.

Clearance lights legal in one state are of the wrong color when a vehicle is crossing the state line. In Indiana, for instance, trailers must be equipped with green lights at the front, red lights at the rear, but when an Indiana operator goes into Kentucky the law requires red lights at the front and green at the rear. In other words, the driver is forced to change front and rear lights when he is crossing the state line. A bus operating in the District of Columbia requires blue or purple lights at the front, but in Delaware the front lights must be white and in Pennsylvania they must be green. A truck operating in Michigan is required to have three green lights at the front and also at the rear, but when this truck crosses the state line to go into Indiana and Illinois the Michigan green lights at the rear are illegal, as these other two states require red lights at the rear.

Clearance lights on the side of vehicles are also subject to a multiplicity of specifications, in some cases on the left side only, in other states on both sides of the vehicle. Several states require the side clearance lights in the upper portion of the vehicle, others at the lower portion of the body, others require certain specified distances from the ground with regulations for visibility ranging anywhere from 150 to 500 ft.

Reflectors—Specifications for reflectors again show a variety of colors, such as amber, blue, green, purple, red, white, and others not specifying any definite color. Again in location of reflectors and all other specifications, such as visibility distance, there is lack of uniformity. The same applies to headlights, rear lights, and stop lights.

Coupling Devices and Safety Chains—26 states have enacted laws affecting the specifications of coupling devices, and these regulations also require different designs with no apparent intention for uniformity.

Directional Signalling Devices—Regulations on the requirements of directional signalling devices have been enacted in 24 states and here there is a noticeable tendency for greater uniformity, as only two colors are specified in the laws of these 24 states, namely, red and yellow.

Horns and Warning Devices—Horns and warning devices have been a subject for regulation for the past 30 years, yet the standpoint of uniformity is still a problem unsolved by our state legislators. Perhaps the most unusual legal requirement has been enacted in the State of Virginia, which requires that trailers and semi-trailers must also be equipped with a horn. In South Carolina and Kentucky all 4-wheel vehicles must be equipped with a horn, or some kind of warning device, which apparently includes trailers also.

Rear-View Mirrors—Rear-view mirrors are compulsory in 45 states. Size and location of is to be published for the information of the com- rear-view mirrors are subjects of a variety of regulations. In some states they must be round and of certain dimensions. Trucks in Vermont for instance, must have a 5 in. diameter rear-view mirror, but when a Vermont truck goes into Maine the diameter of the mirror must be 6 in. In other states rear-view mirrors must be oblong. California definitely specified that school buses must be equipped with a rear-view mirror 3 in. wide by 15 in. long. Perhaps the most unusual provision concerning rear view mirrors is found in the Pennsylvania law which requires that all persons with less than two per cent normal hearing must have cars with rear view mirrors.

Windshield Wipers—Windshield wipers are required in 20 states. The lack of uniformity is also noticeable in specifications for miscellaneous equipment such as governors, locks, steering mechanism, bumpers, fenders, mud guards, fuel tanks, fire extinguishers, et cetera.

When a school bus is operating in Ohio, or Michigan, and the bus is driven into Indiana, the driver is liable to be arrested unless he stops at the hardware store on the Indiana line and buys himself a new pickaxe. School-bus drivers in New York State also are compelled to have a pickaxe handy within easy reach.

Size and Weight Restrictions—In the Federal Motor Carrier Act, Section 225 gives the Interstate Commerce Commission the authority to investigate and report on the need for Federal regulation of sizes and weights of motor vehicles. We believe that this provision in the Motor Carrier Act will eventually help to simplify not only the manufacturer's problems, but will also greatly reduce the intricate problems confronting interstate truck operators.

The 49 varieties of size and weight laws have been a serious problem for the manufacturers, endeavoring to conform truck design to meet these various state laws. We are thoroughly in accord with attempts to bring about a greater uniformity of size and weight restrictions and during the last two years the Uniform Code originated by the American Association of State Highway Officials has been very helpful. This Uniform Code recommends dimensional limitations as follows:

Width 96 inches
Height 12½ feet
Length for single vehicles 35 feet
Length for combinations 45 feet

This code has been accepted and approved by

the manufacturers, but has not as yet been fully indorsed by the operating groups. Perhaps one of the most objectionable features is found in the length limitations for tractor semi-trailer, which in the code is considered as a single vehicle and therefore subject to the 35 foot limitation. In many states a tractor semi-trailer is considered as a combination. In Michigan, for instance, we have a length limitation of 50 ft for a combination of vehicles and the tractor semi-trailer is considered as a combination, *not* a single vehicle. As evidenced by several laws enacted during 1934, there is a tendency to disregard this code recommendation and allow more liberal dimensions for tractor semi-trailer length.

Colorado perhaps last year passed the most practical length limitations as follows:

Single vehicle 35 feet
Tractor semi-trailer 40 feet
Combination of vehicles 50 feet

Weights—Axle weights of 18,000 lb for balloon tires and 16,000 lb for other types of tires, as recommended in the Uniform Code, are entirely practical and acceptable to the industry. However, the Uniform Code has no definite recommendation on gross vehicle weights, and this does not lead to greater uniformity of weight laws. From the manufacturer's standpoint, we feel that axle weights should be used as the basis for weight restrictions, taking into consideration the number of axles according to practical design limitations.

The L Plus 40 Formula, as originally recommended in the Uniform Code, serves the purpose for protection of bridges against excessive concentration of gross weight with vehicle combinations. The Co-Efficient of 700, as recommended in the Formula, is adequate for average conditions, but on all Federal-aid highways a higher Co-Efficient is practical and desirable to correspond more closely to the 18,000 lb maximum axle weight and also with practical design limitations.

Lack of uniformity in size and weight limitations is forcing manufacturers to build a variety of special-design vehicles, in order to comply with the multiplicity of state laws. Pavements and bridges on all Federal-aid highways are being built according to standard specifications of the U.S. Bureau of Public Roads and we are in hopes that Section 225 of the Federal Motor Carrier Act may bring about a uniform Federal Code or ruling, under which a standard type of vehicle or combination of vehicles can be developed to operate on all Federal-aid highways without being hampered by 49 varieties of state laws.

Committee Starts Work On Soap Specifications

A critical review of existing specification requirements for soap will be the first undertaking of the specifications subcommittee of the newly organized American Society for Testing Materials' Committee on Soap and Detergents. The subcommittee will start preparing new specifications, after it has completed its preliminary study.

Other subcommittees working under this new committee on Soap are those on Methods of Analysis and on Nomenclature.

Soaps and detergents, including the materials entering into their manufacture, will be the scope of the general committee.

H. P. Trevithick, Chief Chemist, New York Produce Exchange, is chairman of the committee; F. W. Smither, National Bureau of Standards, is vice-chairman; and B. S. Van Zile, Colgate-Palmolive-Peet Company, is secretary.

The subcommittee on methods of analysis will include a number of members of the soap committee of the American Oil Chemists Society and is expected to review the methods of analysis developed by the A.O.C.S. committee with a view to recommending their adoption by the Society.

The work on nomenclature will probably start with a consideration of definitions of different types of detergents.

Reduce Varieties Of Paving Brick

Four varieties of vitrified paving brick have been selected for inclusion in the newly revised Simplified Practice Recommendation R1-35, Vitrified Paving Brick. The original recommendation, which became effective in 1922, made possible a reduction in variety from 66 to 11, and the current revision reduces the number of varieties to 4. The revision is based on a survey of 1935 shipments, which represented 98 per cent of the total capacity of the industry.

The new revision became effective June 30, according to an announcement by the Division of Simplified Practice, National Bureau of Standards.

Printed copies of the revised schedule, designated as Simplified Practice Recommendation R1-36, Vitrified Paving Brick, may be obtained from the Superintendent of Documents, Government Printing Office, for five cents each.

Choose Two Film Widths For Copying Documents

Two standard stock widths of motion-picture film, 16 millimeters, and 35 millimeters, have been approved by those interested as the first step in the orderly advancement of the art of copying, says an announcement from the Division of Simplified Practice, National Bureau of Standards. The recommended widths of film, given in Simplified Practice Recommendation R 165-35, became effective August 1, 1936.

When copies of records, manuscripts, books, newspapers, fragile volumes, or rarely accessible documents are needed it has been found that miniature-size images of such documents on photographic film are practical and convenient to make. Students, technicians, and librarians make use of such copies most frequently when it is necessary to study documents at leisure and away from the originals. They have found "movie" films most convenient for such use because they are readily available in other countries. Use of cameras and reproduction devices is increasing rapidly, therefore, and has resulted in the need for careful and accurate design of the necessary apparatus.

A representative standing committee will keep the Simplified Practice Recommendation, just approved as the first step in standardization, abreast of current technical research on the relationship of film width to lens systems, sprocket holes in films, recorded image-size, reduction ratio, and film emulsions. The study is being coordinated, says the Division of Simplified Practice, in order that essential apparatus may be designed, built, and distributed, with the assurance that abrupt changes in method or technique will not hamper the users.

It is expected that a uniform nomenclature, international in usage, may also emerge from a present consideration of terms commonly used in this field of activity. In the past, photographic copies made by this method have been variously described as "micro-copies," "film slides," "filmstats," etc.

Inquiries concerning the new recommendation should be addressed to the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.

Musicians Tune to Radio; Standard "A" Is Broadcast

The musician's standard "A" tone will be broadcast for two weeks August 29 to September 12 in a test arranged by the National Bureau of Standards for the benefit of musicians, musical instrument manufacturers, piano tuners, and others having need for an accurate standard of pitch. During the test the standard pitch will be broadcast continuously day and night except from noon to 3:30 p. m. Eastern Standard Time on Tuesdays, Wednesdays, and Fridays. A low-power transmitting set will be used. The broadcast will be on frequencies of 5,000, 10,000, and 15,000 kilocycles per second, simultaneously.

The test was arranged at the request of a number of musical organizations and, if it is successful, regular broadcasting of the standard pitch may be arranged by the Bureau.

Anyone wanting the service is asked to listen in during these tests and write to the Bureau, reporting on the reception and giving ideas on the usefulness of such broadcasts.

More specific information about the test broadcasts may be obtained by writing to the radio section of the National Bureau of Standards, Washington, D. C.

Railroad Association Receives Materials Specification Report

At the fifteenth annual meeting of the Mechanical Division of the Operations and Maintenance Department, Association of American Railroads, Chicago, June 25 and 26, the report of the Committee on Specifications for Materials was one of several received.

This committee recommended minor revisions in several specifications, including those covering carbon steel axles for cars and locomotives, boiler tubes, structural and boiler rivet steel and rivets, pipe, boiler and fire box steel for locomotives, steel castings, chain, hollow and solid staybolt iron, and steam and hot-water hose.

Most of the recommended revisions, which were accepted at the meeting, were minor in character and were intended to clarify the requirements or to bring the requirements into line with other standards or current industrial practice.

Standard Noise Measurement To Benefit Auto Industry

The new American Standards for noise measurement and sound level meters will be useful in production, design, and operating of automobiles, as well as practically every other part of the automotive field, says the *Journal* of the Society of Automotive Engineers, in calling the new standards to the attention of SAE members.

Purchasing Profits Due to Standards

by

Edward T. Gushee

Vice-President in Charge of Purchases, Detroit Edison Company

Standardization Studies Show How Buying Can Save Thousands of Dollars a Year

THE purchasing department is fundamentally a coordinating service department for the rest of the company. It consequently is ideally fitted to start a drive for standardization.

There are any number of items which we all purchase and which we think have been adequately studied, but which have become a matter of routine or of such comparatively slight recognizable importance that they tend to be bought in routine manner. This, I think, is true no matter how well organized the given purchasing department may be.

Standardization, which is a study of materials, pulls all these obscure items into the limelight. It becomes much more than a mere attempt to cut down the number of different items of the same sort bought or used. Its great importance is that it is a material study.

I do not mean to infer that these studies are carried on solely by the purchasing department. I am talking about functions, and not the organization of the thing. In a large company, if intra-company standardization is carried on, it is likely to be very costly to start as well as for some years thereafter. Once standardization has been practically accomplished, the cost of revisions and keeping up to date is comparatively incidental.

So firm is my own belief in the efficacy of this work that I could almost promise any company which has not already intently studied its purchases from this angle a return on such a study of thousands and thousands of dollars.

The chief immediate dividends come from material study, but there are indirect dividends from the actual cutting down on the number of items—the consequent decrease of paper work, of stocks, and, in general, simplification. But these dividends are, while palpably there, indirect and hard to get at. We are thinking today in terms of actual, cold, hard profit, not subject to question; and these profits are inherent in intra-company standardization.

May I illustrate both types of dividends, the indirect and the direct.

The indirect benefit can best be illustrated by reciting some of the items in which standardization resulted in a decrease in the number of units handled. In a study of hand tools the number was cut from 7,000 to 3,000; wiring supplies, 1,200 to 641; fly exterminators, from five to two; etc., through a long list.

Again—a direct case—as a result of the standardization studies, a wheel was developed for cutting firebrick which resulted in a net saving per year of $3,000.00.

There are numerous other instances of saving from five to forty thousand dollars a year, directly resulting from this work.

[1]Abstract from address before the National Association of Purchasing Agents' National Convention. For complete address, see *Philadelphia Purchasor*, June and July, 1936.

Lectures Will Tell How Management And Technicians Can Use Standards

A series of lectures on industrial standardization, considered from the management, as well as from the technical, point of view, will be given in New York City this fall by Dr. John Gaillard. The lectures will begin probably during the week of September 28.

An outline of the subjects to be considered is being prepared for publication in a prospectus, and will also be announced in a later issue of Industrial Standardization.

Dr. Gaillard, an industrial engineer, is mechanical engineer on the staff of the American Standards Association.

How Enamel Resists Acid

Bureau of Standards May Standardize Tests

As a part of its general program of cooperation with the Porcelain Enamel Institute, the National Bureau of Standards has been developing a test to determine the degree of acid resistance of different enamels, which might be adopted as a standard.

One test method—determining the degree of attack caused by a specified treatment with acid—gave promising results. For articles to be used at room temperature, the treatment consisted of contact with 10 per cent citric acid at room temperature for 15 minutes. For cooking utensils, the treatment consisted of contact with a boiling solution of 2.5 per cent malic acid for half an hour. Three degrees of attack could be distinguished visually:

(*a*). No visible attack
(*b*). Attack visible, but insufficient to decrease ease of erasure of a pencil mark
(*c*). Attack sufficient to prevent erasure of a pencil mark with a wet cloth

While these three classes may be sufficient for commercial classification, says a report of the tests in the August issue of the *Technical News Bulletin*, research work requires the detection of numerous degrees of acid resistance. For this purpose, the loss of specular (mirror) reflection caused by the acid, as determined by a Hunter glossmeter, was taken as a criterion of the resistance and a table giving the results obtained on different specimens was prepared. The table is included in the *Technical News Bulletin* article.

The Nation Announces Change To American Standard Style

The Nation has changed its practice of publishing its volume numbers in Roman numerals and will now use Arabic numerals to conform to the American Recommended Practice for Reference Data for Periodicals. There will be two volumes published each year, as now, beginning January and July. The issue of June 27, 1936, was Volume CXLII, Number 3704. The issue of July 4, 1936, was Volume 143, Number 1. The issues of the magazine in each volume will be numbered from 1 to 26.

"As *The Nation* is indexed in five American indexes and two foreign indexes, we hope the new system will prove more convenient in reference work," the announcement of the change says.

The American Recommended Practice for Reference Data for Periodicals was prepared at the request of the American Library Association to help make periodicals easier to use. Uniform location of information about the periodical, continuous paging of the magazine throughout a volume so that articles can be easily located, use of Arabic rather than Roman numerals, are some of the more obvious rules laid down in the recommendations.

It was intended that the recommendations should be filed in each publisher's office, in such a manner that they may be referred to by editorial and make-up people, and put into practice wherever possible.

ASA Library Offers New Standards Service

Several Company Members of the American Standards Association are already making use of a new form of service offered by the ASA Library. Companies which are using American Standards or other technical or trade association standards frequently find it difficult to keep them up-to-date with new revisions. If Company Members will send a list of the standards they are using to the American Standards Association, the ASA Library will check their lists three or four times each year, and will send all new editions or revisions of standards to replace those already in use.

Company Members interested are invited to write the American Standards Association for more information about this service. A sample form for compiling such a list, in order that the checking may be done most efficiently, will be furnished upon request.

Issue Symposium On Lubrication

A symposium on lubrication is published in the August, 1936, issue of the *Pacific Purchasor*. The series of articles discusses lubrication problems of automobiles from the viewpoint of both the individual and the fleet owner, the selection of a lubricating oil for various purposes, diesel fuels, and the significance of provisions and tests in specifications.

Copies of this issue may be obtained from the Pacific Purchasor, 433 California St., San Francisco, Calif., at 20 cents each.

Business and Government Cooperate For Progress in Standardization[1]

by

Dana D. Barnum[2]

President, American Standards Association

"SUCH simple things as bolts and nuts bind together the mechanical skeleton of our civilization," says Ralph E. Flanders, a recognized spokesman of the Machine Age. "These threaded parts are essential components of our culture."

It was early in 1920 that the American Standards Association, acting on the initiative of the Society of Mechanical Engineers and the Society of Automotive Engineers, undertook a project on the standardization of bolt, nut, and rivet proportions. The effects of this work are felt today by manufacturers of products as diverse as baby carriages and aeroplanes. One company which had formerly been paying from $50 to $70 per 100 for a certain bolt was able, after general adoption of the standard had brought down manufacturing costs, to secure the same type of bolt for $9 per 100, a saving of over 80 per cent on the original price. The work not only resulted in economy and convenience to scores of industries but the improved product made possible by it has been a definite aid to American manufacturers in their export trade.

One Organization Needed

To accomplish this it was necessary for one organization to bring into unity all the work on bolts, nuts, and screw threads that was being carried on by various trade association and technical societies throughout the United States. This organization was the American Standards Association, a federation of trade associations, technical societies and government bureaus, that acts as a clearing house for standardization in the United States. It has been in the standardization business eighteen years and as a result there are today 348 American national standards and safety codes approved and in use. Most of these, like the bolt, nut, and rivet proportions, ramify into many branches of industry.

I have been connected with the organization for a number of years and I do not know of any organization that has more to show in the way of actual services to industry than the American Standards Association; and all this work has been accomplished with little fuss and on a very small budget. *I believe that many firms today are reaping the benefits of ASA work without even knowing of the organization's existence.*

Notable Record

The ASA has a notable record of achievement in a number of fields involving standards having to do with regulatory matters, as well as in the field of mechanical standards. Cooperating closely with government and industry, its work has served both in many important ways. It is a cardinal principle with the ASA that ordinary technical standards shall be upon a strictly voluntary basis, and the greater part of the Association's work is of this nature—specifically for materials, mechanical parts and the like.

On the other hand, one scarcely needs to examine the law books to recognize the many cases in which standards are necessary which involve safety to life and property. Consider the chaos that would result if traffic lights were different in every state.

Governmental agencies are often required by existing law to issue and administer regulations to protect the public or industrial employees from hazards to life or to property. There are many occasions where such protection is necessary—

"The ASA is making a new and major contribution in the relations between government and industry in regulatory matters — and doing it to the satisfaction of both government and industry."—*George B. Cortelyou.*

[1]Abstract of article published in *Industry*, August, 1936.
[2]President, Boston Consolidated Gas Company.

such as safety standards for the traffic problem, building code provisions, and protection to workers in industrial plants.

Sixteen years ago the American Standards Association started work on a program of safety codes which today have been adopted in whole or in part by twenty-five of the thirty-four states which have regulations for the protection of industrial workers. Pennsylvania has adopted four in their entirety; Maryland, twenty-six. This work came as a result of the disturbing effect that state regulations which did not agree with each other or with insurance regulations exerted on industry. Insurance and state inspectors often disagreed on vital problems of accident prevention. Manufacturers were annoyed; insurance companies were annoyed. Finally, industrialists took the matter up through the National Safety Council, as a result of which the National Bureau of Standards called two conferences in 1919. At these conferences it was decided to launch a comprehensive program of national safety codes that would serve to pool the skill and experience of all the groups concerned in each problem, and would serve as a basis for developing industrial safety codes, national in scope and satisfactory to all groups. The result was the program of safety codes, forty of which are today complete and in extensive use by industry, by insurance companies, and by the state government. This is one example of industry rising to the occasion in the matter of self-regulation.

Does Not Initiate Projects

The American Standards Association itself initiates no projects. Its main function is to serve as a clearing house for the standardization problems brought to it by industrial or governmental groups. In the matter of bolt, nut, and rivet proportions, the ASA could not move until a request had been received from the Societies of Mechanical and Automotive Engineers. Usually, a general conference of industry is held before work commences, but in this case the need for standardization was so well known that a conference seemed unnecessary. The American Standards Association invited the two engineering societies to assume leadership in the technical work. A committee was organized which, like a miniature legislature set up along industrial lines, included every group that would have an interest in the finished work. There were altogether fifty members, representing twenty national organizations; and two years of solid research went into the development of the resulting standards. One major issue revolved around a sixteenth of an inch in the width of the nut, and differences in the manufacturing processes involved led two companies to spend $10,000 apiece on special machines to test the strength and wear of the nuts through simulated use. But in the long run, the value of these standards to the industrial groups concerned has more than justified the expense and difficulties of the research work.

All Groups Cooperate

An important feature of the ASA method is that all interested groups cooperate in the development of the standard. Thus, obstacles to its acceptance are normally cleared away within the committee. This basic principle of the American Standards Association in developing standards—the assent, affirmatively expressed of the groups with a real concern in the finished work—has underlain much of its success.

Some years ago there were conditions in my industry, the gas industry, which needed radical improvement. Fifty cities had local ordinances restricting the sale of gas-burning appliances, hampering both operating companies and manufacturers and increasing the over-all cost to the public. The American Gas Association established a national laboratory in order that the industry might regulate itself. Considerable research was necessary. The Bureau of Mines was called in as the technical group most competent to set toxic limits for the presence of carbon monoxide in the air we breathe, and returned a decision of 0.04 of 1 per cent. Our industry, with the cooperation of all interested groups, acting under ASA procedure, has now developed twenty-five standards covering approval and installation requirements for gas-burning appliances based on this limit—standards that in less than two years led to the redesigning of every water heater on the market and many of the ranges. The American Standards Association by providing a nationwide agency for the development and approval of standards has done the gas industry an immeasurable service. Now, as a result of these standards and the accompanying improvement in products, the industry is no longer pestered with restrictive local ordinances.

Provided Self-Regulation

This was an outstanding job in the field of public relations. It provided for self-regulation. It made legislation unnecessary. The improvement in the product and the publicity which the work attracted led to increased consumer acceptance of gas-burning appliances in general.

When both Mr. Sibley, president of the U. S. Chamber of Commerce, and Secretary of Commerce Roper, speaking at the recent meeting of the Chamber of Commerce in Washington, point-

ed out the need of closer and more effective co-operation between industry and the government they might well have taken the work of the American Standards Association as an example of how such cooperation could be accomplished.

In contrast to the general trend toward government regulation of business, the American Standards Association has been asked repeatedly by both state and federal governments to take over and carry forward certain functions formerly performed by government. The whole program of the ASA Building Code Correlating Committee has been undertaken by request of the Secretary of Commerce.

Asked to Cooperate

Within the last six months the Interstate Commerce Commission asked the Association to assist in drawing up specifications for the regulation of buses and trucks in interstate commerce. This request, which has been carried out by cooperative action of the interested groups, was a tribute to the Association's very successful safety standards in the traffic field, including Standard Colors for Traffic Signals, now in use in all forty-eight states, and Specifications for Safety Glass.

I have spoken of the safety code program of the Association. The acute legal situation in regard to silicosis and other occupational diseases has led to a similar program in the field of industrial health codes. Last winter when the Department of Labor decided to enter this field, a clearance arrangement was made with the American Standards Association, under which any safety code or occupational disease code which the Department's Division of Labor Standards recommends to the states will first be submitted to the ASA. The tremendous stake that industry has in this work may be judged by the claims that are today costing manufacturers and insurance companies millions of dollars in compensation cases. The development of adequate standards in this field will:

1. Protect employees from unhealthful working conditions.
2. Protect industrial concerns from racketeering in liability cases.
3. Provide recommendations to serve as the basis of regulations promulgated by state governmental agencies, and to be rendered by insurance companies to their assured.

Need Cooperation

Mr. Sibley and Secretary Roper were right: We do need more cooperation between government and industry, cooperation of the sort that we had in the development of the standards for gas-burning appliances and in the Electrical Safety Code. For better public relations, I offer you the methods of the American Standards Association. The American Standards Association was founded eighteen years ago by five major engineering societies. Today it has a membership of fifty-five national trade associations, technical societies, and government departments. Its policies are controlled by a Board of Directors, chosen according to industry from the membership. Its technical work, including approval of standards, is in charge of a Standards Council on which every member has a vote. This work is supported by government bureaus and by industry. ***It has been so successful in the work it has done in the past years that both industry and government are calling upon it to extend its operations. This can and will be done just as rapidly as industry gives the Association the necessary additional support.***

Autos Need New Bumper Standards

One of the factors that is frequently discussed in connection with safety in the design and operation of motor-vehicles is a suitable standard for bumpers. Although the present SAE Standard was revised in 1931, more recent developments in passenger-car design necessitate a review of this standard. A survey of the vehicle manufacturers is in progress, the results of which will be referred to the Parts and Fittings Division of the Society of Automotive Engineers' Standards Committee, under the chairmanship of W. C. Keys, to which this subject was assigned.—*S.A.E. Journal, June, 1936.*

Government Departments Issue Basic Airplane Information

Basic information on material properties used in calculating the strength of airplane structures has been issued by the Army-Navy-Commerce Committee on Aircraft Requirements in the *A-N-C Materials Handbook.* This first edition of the Handbook was prepared to serve as a basis for discussion and revision, according to the explanatory note accompanying the book.

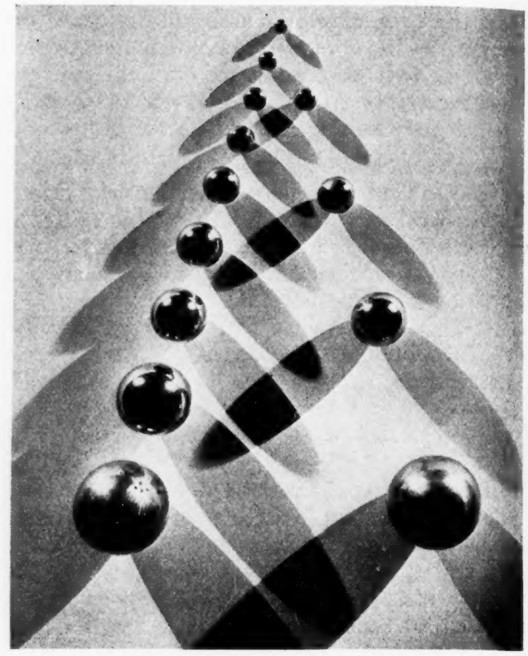
Copies may be ordered through the office of the American Standards Association, without charge.

Preferred Numbers

This picture, used for the front cover of our July issue, illustrates two series of sizes according to the new American Standard Preferred Numbers. Approval of the standard was announced last month.

The picture was made by McGraw-Hill Studios, Inc.

The steel balls, in sizes of two preferred number series, were furnished by SKF Industries, Inc. To our regret, credit for this cooperation was omitted in the July issue. *Industrial Standardization* is glad to take this opportunity to express its appreciation to SKF Industries for its assistance in furnishing the balls in the required sizes.



McGraw-Hill Studios

Bureau of Standards Investigates Tensile Properties of Brick

A study on the tensile properties of the standard 9-inch size of firebrick, and also the extent of the variation in these properties within the brick and between bricks, has been made by the National Bureau of Standards.

The Bureau's report on the study has just been released for publication, giving information on the tensile properties of 16 brands of fire-clay brick, two of high alumina and one each of silica, chrome, forsterite, and mullite.

The brittleness of refractory products has in the past been a serious handicap to the study of their tensile properties. Within recent years, however, the development of the optical strain gage for measuring minute length changes has given the research worker a tool which has eliminated most of the difficulties encountered in such a study. Strain measurements of all types of refractory materials can now be made with reasonable accuracy.

Refractories are ordinarily subjected to comparatively small external loads, but more information on their little-known structural properties may lead to a better understanding of their behavior in certain types of service. Information on the tensile properties of fired refractory products is especially desirable because of the trend toward the use of fairly large shapes in hanging roofs designed for modern, high-power boiler settings, heat treating, and other furnaces.

The results of this study will be published as Research Paper 923 in the September *Journal of Research* of the National Bureau of Standards.

Greek Standardizing Group Joins International Society

The national standardizing body in Greece has become a member of the International Standards Association. Greece thus becomes the twentieth country to affiliate with the ISA, the other members being the national standardizing bodies in Austria, Belgium, Czechoslovakia, Denmark, Finland, France, Germany, Holland, Hungary, Italy, Japan, Norway, Poland, Roumania, Spain, Sweden, Switzerland, the U.S.S.R., and the United States.

"ASA Is Fountainhead Of National Standards"

The American Standards Association is the fountain head of national engineering standardization. The work of three ASA sectional committees has had profound influence on power piping; namely, B16 on pipe flanges and fittings, B31 on a code for pressure piping, and B36 on wrought iron and steel pipe. Sectional committee B31 began its work in 1926 and last year the Tentative American Standard Code for Pressure Piping was issued in printed form. This committee was a large group of exceptional ability which did a big job exceedingly well.—*From "Power Piping Requirements" by J. Roy Tanner, Heating, Piping, and Air Conditioning, July, 1936.*

A. G. A. Testing Program Now Covers Liquefied Petroleum Gas Appliances[1]

New Requirements for Propane-Fuel Stoves, Revising Gas Range Standard, Approved by Sectional Committee

IMPORTANT steps in extending the American Gas Association's program for use of approved gas appliances meeting American Standard requirements in the field of liquefied petroleum gas have been taken recently.

The liquefied petroleum gas industry, through its national trade groups, the National Bottled Gas Association and the Compressed Gas Manufacturers' Association, has agreed to recognize the American Gas Association Testing Laboratories as an official testing agency and to connect only appliances bearing the Laboratory Seal of Approval. Heretofore, all the larger propane distributors had maintained their own testing laboratories and applied their own individual requirements, even though American Standard Approval Requirements for propane-consuming equipment had been developed by the American Gas Association and had been in effect for some time.

Consequently, manufacturers of appliances, in order to have their products connected in propane-fueled homes, were required to submit their appliance to each distributing company for approval. The same appliance with minor modifications would also, in many instances, be submitted to the American Gas Association Testing Laboratories for approval for use with regular city gases. This, of course, resulted in considerable expense to the manufacturer.

When the bottled gas interests pledged themselves to recognition of the Testing Laboratories as an official testing agency for propane appliances and adopted the policy of selling and connecting only American Gas Association approved models, the ground work was laid for the elimination of confusion and duplication of effort that had existed heretofore.

It was understood in making the arrangements that the Association's standards for propane appliances would be revised to embody the recommendations of the propane gas industry so far as feasible, and further, that representatives of the propane gas industry would be added to several of the American Gas Association requirements

Use of Liquefied Petroleum Gas Increases 36 Per Cent in 1935

Last year, 76,855,000 gallons of liquefied petroleum gas (propane and butane) were used in industrial and domestic consumption, 36.2 per cent more than in 1934. There were 241,000 bottled gas (mostly propane) customers in 1935—30,000 more than in the preceding year.

Propane is used most extensively in the home; butane in industry.

It is made of hydrocarbons ordinarily found in natural gas. Although originally natural gas alone was the source, liquefied petroleum gas is now manufactured in some of the oil refineries as an outgrowth of modern crude-oil cracking processes.

Impurities are removed, and the gas is then compressed to a liquid state for economy in shipping and distribution. When relieved of pressure it becomes a gas again and is piped into the house or factory as gas to be used in all types of gas appliances.

At the end of 1935 liquefied gas was being delivered to 163 communities in 29 states as their sole gas supply.

[1]Abstracted from an article published in the American Gas Association Monthly, April, 1936.

committees. To further aid in the cooperative effort, the Compressed Gas Manufacturers' Association and the National Bottled Gas Association have formed a "Joint Committee on Propane Appliance Requirements."

In line with the above action, the gas range subcommittee of the American Gas Association, at its January meeting, considered a number of revisions to the range standards which were recommended by the propane industry. Three representatives from the propane gas industry were present at the meeting.

The revisions adopted at that time, and which were applicable only to propane gas ranges, were ratified to become effective as soon as approved by the Sectional Committee on Approval and Installation Requirements for Gas-Burning Appliances (Z21), A.G.A. Approval Requirements Committee. The revised requirements were immediately submitted by letter ballot to the sectional committee and were approved by that body for immediate application to all propane ranges subsequently submitted for approval. They are now being applied by the Testing Laboratories.

Other clauses of the gas range requirements revised at the January subcommittee session but applying to ranges designed to be used on city gas supplies, along with revisions adopted at the June, 1935, and March, 1936, meetings, will be printed and distributed for criticism and will subsequently be made effective in the regular manner.

Burt Named President Of Niles-Bement-Pond

Clayton R. Burt, formerly president of Pratt & Whitney Company, and recently retired as a member of the Board of Directors of the American Standards Association, was elected president of Niles-Bement-Pond Company in June. The Pratt & Whitney Company, formerly a subsidiary of Niles-Bement-Pond Company, was recently merged with the parent company.

Following a wide experience in the machine tool industry, Mr. Burt joined Pratt & Whitney in 1924 and became president in 1930. He had been with Brown & Sharpe Company, Providence, R. I., Barber-Coleman, Rockford, Ill., and during the war he equipped and operated four large munitions plants in Ontario, Canada, and two in Buffalo. He was honored by the British and United States governments for his work.

He is first vice-president of the National Machine Tool Builders' Association and was a director of the American Standards Association from 1932 to 1935.

Analysis of Fuel Knock Ratings May Affect Test Method Revisions

An analysis of data obtained in cooperative knock ratings of fuels for internal combustion engines, which may have an effect on future revisions of the American Tentative Standard Method of Test for Knock Characteristics of Motor Fuels,[1] has just been completed by the National Bureau of Standards.

The analysis was made to determine the normal experimental error and the factors affecting the precision of rating.

Committee Asks Analysis

It was done at the request of the Cooperative Fuel Research Steering Committee which developed the apparatus and test procedure on which the present American Tentative Standard is based. Representatives of the American Petroleum Institute, the National Automobile Chamber of Commerce, the Society of Automotive Engineers, and the National Bureau of Standards are members of the committee.

The analysis just completed is based on 2,180 tests of 99 fuels. For 1,882 tests made under the standard procedure, the probable error for the average of these fuels is 0.465 octane unit. The precision of rating is very nearly the same for straight-run gasolines, for blends of straight-run and cracked, and for leaded fuels of any base. The experimental error is distinctly larger for non-leaded cracked gasolines, and is still greater for benzol blends. Over the range of commercial fuels, the error of rating decreases with increasing octane number, being 0.5 unit at 55 octane number, and 0.4 unit at 75 octane number. From a consideration of the data, it appears that the probable error can be kept down to $\frac{1}{4}$ octane unit with present equipment, if suitable precautions are observed.

Within the ranges covered by the tests analyzed, the result of a knock rating is not affected materially by ambient air temperature or barometric pressure, or dry-air pressure. The octane number obtained in a rating varies in some cases with humidity. The knock rating of sensitive fuels decreases as engine carbon increases. Variations in the intensity of knock used in testing contribute materially to the error of rating.

From this analysis the indications are that the precision of knock ratings might be improved by the use of conditioned air and limitation of the period between engine overhauls to 50 hours, at least when testing sensitive fuels.

[1]ASA Z11.37-1935; A.S.T.M. D 357-34 T.

31 New Standards, 108 Revisions Accepted at A.S.T.M. Meeting

76 Tentative Specifications to be Adopted as Standard, for Inclusion in 1936 *Book of A.S.T.M. Standards*

A RECORD-BREAKING attendance, and action on an unusual number of proposed new standards and tentative standards, made the 1936 (Thirty-Ninth) A.S.T.M. Annual Meeting, at Atlantic City June 29-July 3 an outstanding one.

Thirty-one new specifications were accepted for publication as tentative, and 76 existing tentative specifications and tests were approved for formal adoption as standard. Revisions in some 70 existing standards and in 38 tentative specifications were approved.

Existing research projects were reviewed and a number of new research investigations authorized.

The main features of the meeting were the Symposium on Radiography and X-Ray Diffraction Methods and the Symposium on the Limitations of Laboratory and Service Tests in Evaluating Rubber Products. The Symposium on Radiography, one of the most extensive yet sponsored by the Society, will be published in one volume later in the year.

Meetings of committees during the A.S.T.M. Annual Meeting featured reports of actions on standards and papers on various research problems. Some of the outstanding actions taken on standards and research having a direct effect on standards were reported as follows:

Ferrous Metals

Eight new specifications, approved for publication as tentative, cover high-carbon and quenched carbon-steel joint bars, structural nickel steel, two types of concrete reinforcement—bar or rod mats and welded wire fabric, seamless alloy-steel 4-6 per cent chromium still tubes and heat-exchanger and condenser tubes, and one-wear and two-wear wrought steel wheels. The new structural nickel steel specifications supersede the existing standards and provide a higher strength.

Important changes were approved in the Tentative Specifications for Carbon-Steel Castings for Miscellaneous Industrial Uses. Three new grades specified to be full annealed are covered by the approved changes. The grade requiring tensile strength of not less than 66,000 lb per sq in. fully annealed was listed at the request of producers and purchasers of castings for bridges.

A new specification for single and double refined wrought iron bars was approved. The requirements cover a grade of high-quality single-refined and a grade of high-quality double-refined iron. Requirements were prepared in order to have available a standard covering high-grade bars which does not permit the use of admixtures of purchased iron scrap or steel.

New specification requirements for light-weight, thin-sectioned, gray-iron castings cover material in which appearance, machineability, and dimension tolerances are primary considerations. The requirements establish a standard of quality for light castings based on the visual inspection of sample castings, and testing at representative locations on sample castings for machineability. Strength is not a primary consideration in the specification.

The Committee on Corrosion of Iron and Steel proposed a method of test for uniformity of coating by the Preece test (copper sulfate dip) on zinc-coated (galvanized) iron or steel wire, which was approved for publication as tentative. The committee felt that because this test was generally used in industry, approved technique for its use on wire should be standardized and the limitations carefully and plainly stated. The proposed method states that the test is designed as a factory inspection or acceptance test on new material and is useful only for determining which are the thinnest portions of the coating. The fact that different processes of galvanizing produce coatings having widely varying rates of solubility in the copper sulphate solution precludes

the possibility of using the test for determining relative weights of coating.

Non-Ferrous Metals

Ten distinct grades of Copper and Copper Alloy Wires for Electrical Conductors, designated in accordance with increasing conductivity, are provided in a new tentative standard. Tensile strength and elongation requirements as well as electric resistivity are stated. In an explanatory note are listed types of alloys now commonly used for each of the several grades.

Five new tentative specifications on Copper and Copper Alloys, Cast and Wrought, were accepted. They cover seamless copper nickel alloy condenser tubes and ferrule stock, sheet and strip phosphor bronze, bronze castings for turntables and movable bridges, bronze castings in the rough for locomotive wearing parts, and car and tender journal bearings, lined. The three latter specifications are, essentially, revisions of previously existing standards which were withdrawn.

A new tentative standard covers the determination of flexure-temperature characteristics of thermoflex (thermostatic metals) in the form of flat strips.

A new tentative specification covering magnesium-base alloy bars, rods, and shapes was approved.

Testing and Spectrographic Analysis

The Committee on Methods of Testing recommended the adoption as standard of existing tentative methods covering verification of testing machines, Rockwell hardness testing, and definitions of terms relating to methods of testing.

Extensively revised and improved Methods of Chemical Analysis of Steel, Cast Iron, Open-Hearth, and Wrought Iron which include procedures for the determination of carbon, manganese, phosphorus, sulfur, silicon, copper, nickel, chromium, vanadium, molybdenum, titanium, and tungsten have been prepared. These are revisions of the present Standard Methods of Chemical Analysis of Plain Carbon Steel (A 33-24), Standard Methods of Chemical Analysis of Alloy Steels (A 55-24), Standard Methods of Sampling Rolled and Forged Steel Products for Check Analysis (A 130-30), and Standard Methods of Sampling and Chemical Analysis of Pig and Cast Iron (A 64-27).

Rubber Products and Textile Materials

A Symposium on "Limitations of Laboratory and Service Tests in Evaluating Rubber Products," was given at the session on textile materials and rubber products. Papers on tires, rubber footwear, automotive rubber parts, rubber hose and belting, and insulated wires and cables, were included in the Symposium.

Dean Harvey, Materials Engineer, Westinghouse Electric and Manufacturing Company, summarized results of an inquiry on rubber-insulated wires and cables, sent to a number of producers and consumers of rubber-insulated cables, the Underwriters' Laboratories, the National Bureau of Standards, the United States Coast Guards, and the U. S. Bureau of Mines. A significant feature has been the trend toward performance specifications for purchasing rather than specifications for the composition desired, he indicated.

Revisions in the methods of test for adhesive and vulcanized rubber to provide that the machine method may be applicable to both strip and ring specimens were approved. Changes approved in the accelerated aging test eliminate unnecessary testing and make the test work more convenient when minimum specified requirements are established. Revisions which were referred to the Society for adoption were approved in the Standard Methods of Chemical Analysis of Rubber Products (D 297-32). They include a cautionary note which has been inserted in the free sulfur determination for safety reasons.

Four new tentative standards recommended by the Committee on Textile Materials are to be published. These are for (1) testing and tolerances for certain carded cotton gray goods which agree in substance with Specifications "G" of the Worth Street Rules, 1936; (2) test for resistance to slippage in silk, rayon, and silk-rayon woven broad goods, and (3 and 4) determining the fastness to laundering or domestic washing of cotton fabrics, and silk or rayon fabrics. These two latter methods are substantially the same as those appearing in the Commercial Standard for Woven Dress Fabrics—Testing and Reporting sponsored by the Division of Trade Standards of the National Bureau of Standards.

A number of existing tentative standards developed by the committee were approved for adoption as standard, including Methods of Testing and Tolerances for Tubular Sleeving and Braids (D 354-35 T), Woolen Yarns (D 403-35 T), Worsted Yarns (D 404-35 T), and Method of Estimating Hard Scoured Wool in Wool in the Grease (D 232-35 T).

Cement, Lime, Aggregates

Recommendations were approved for revisions of the Tentative Specifications for High-Early-Strength Portland Cement (C 74-30 T) to include a new definition, and to insert optional compressive strength requirements and a fineness re-

quirement prescribing a specific surface of not less than 1900 sq cm per gram of cement. The revised specification is to be submitted to Society letter ballot for adoption as standard.

Concrete and Soils

Three new standards proposed by the Committee on Concrete and Concrete Aggregates were approved as tentative. They cover a method of test for flow of concrete by use of the flow table; making flexure tests using a simple beam with third point loading; and determination of coal and lignite in sand.

Experiments with tests made according to the A.S.T.M. Tentative Method of Test for Soundness of Fine Aggregates by Use of Sodium Sulfate or Magnesium Sulfate (C 88-35 T) and Tentative Method of Test for Soundness of Coarse Aggregates by Use of Sodium Sulfate or Magnesium Sulfate (C 89-35 T) indicated that the procedures are not sufficiently definite nor restrictive to insure uniform test results. It was recommended that another procedure, less sensitive to minor variations in technique, should be adopted to help engineers in continuing to use sodium and magnesium sulfate in accelerated soundness tests of aggregates.

Ceramics, Building Materials, and Paint

The Committee on Refractories presented a new Tentative Method of Panel Test for Resistance to Thermal and Structural Spalling of Super-Duty Fireclay Brick, this being approved as an A.S.T.M. tentative standard. In order to bring out the difference between high-duty brick and super-duty fireclay brick, this method uses a preheat temperature of 1650 C. Nine tentative standards which were recommended by the committee for adoption as standard were approved by the annual meeting for submission to Society letter ballot. These cover clay firebrick for malleable furnaces and for stationary boiler service, ground fire clay, and refractories for construction of incinerators.

A proposed standard covering zinc chloride prepared by Committee D-7 on Timber was approved as an A.S.T.M. tentative standard. Revisions of the Standard Specifications for Structural Wood Joist and Planks, Beams and Stringers, and Posts and Timbers (D 245-33) in the form of separate tentative specifications were approved. The new form does not change the principles underlying the specifications but represents a method of rearrangement and substitution of working stress values for the grade names. The specification provides structural grades designated in terms of the requirements of design and

The American Society for Testing Materials is a Member-Body of the American Standards Association. It is represented on many of the sectional committees working under ASA procedure, and is sponsor for many of the ASA standardization projects.

Sectional committees of the ASA which are working closely with A.S.T.M. committees are those on zinc coating of iron and steel, standardization of dimensions and materials of wrought-iron and wrought-steel pipe and tubing, classification of coals, petroleum products and lubricants, plastering, and sieves. Actions taken by these committees during the past year and reported at the A.S.T.M. meeting are outlined in the July issue of *Industrial Standardization.*

conforms to practical commercial manufacturing conditions.

Ten tentative specifications and tests on preservative coatings were recommended for adoption and will be referred to Society letter ballot. Revisions were proposed in five standards. Active work is contemplated in connection with oiticica oil, a material with properties approaching those of tung oil. It is the hope of the committee that the work will ultimately lead to the development of specifications for this material. Study is now under way of a new method of test for hiding power of paints, working at incomplete hiding and on a dry film basis, that will permit revision of the present method during the coming year.

The organization of a new subcommittee was recommended to prepare specifications for specific complete paints and varnishes.

Petroleum Products and Lubricants

The Tentative Method of Test for Gum Content of Gasoline (D 381-34 T) is to be adopted as standard with certain changes. Several tentative revisions of standards, including the test for viscosity, were approved for submission to letter ballot of the Society.

The Subcommittee on Viscosity prepared a modified Viscosity-Temperature Chart which will be letter size and will be more convenient to file with correspondence than the tentative standard chart, which is twice its size. The modified chart will be published.

The subcommittee is preparing Kinematic-Saybolt Viscosity Conversion Tables which will be based on the best available information. The

tables are necessary for developing the usefulness of the two types of kinematic viscosity methods, which are being published as information.

The Potentiometric Method for Neutralization Number which has been developed jointly with Committee D-9 on Electrical Insulating Materials is to be published for the committee.

Technical Committee B on Motor Oils was authorized to form a new section on Engine Deposits. An article has been prepared which provides recommendations for a uniform practice of changing crankcase lubricating oil. This material should be of particular interest to automobile manufacturers in the preparation of service manuals. The draft was approved, and subject to the favorable reaction of the entire committee, will be given wide publicity.

Changes for the viscosity and ignition characteristics of the present classification of Diesel fuel oils, and also a number of changes in the specification limits of the present tentative specifications for fuel oils were proposed. Recommendations on several American Standards in this field will be presented to the ASA late in August.

Electrical Insulating Materials

A new method of test for saponification number of electrical insulating oils was approved as a new tentative standard. This modified Baader method is suitable for determining the saponification number of used and unused electrical insulating oils, as well as other oils used in the electrical industry.

A test for saponification number on used oils is needed because it furnishes useful information in determining the changes in oils resulting from oxidation and gives a most valuable check on the degree of aging. The changes reflected by the neutralization and the saponification tests have an effect on the electrical conductivity of the oil and are also capable of destroying the insulation.

Committee D-9 has 2400 samples of sheet material ready for comparison tests by different laboratories to determine the effect of conditioning upon impact strength, Rockwell hardness, and power factor. An extensive study to determine methods of measuring the degree of cure of laminated phenolic products and to determine the best procedure to identify grades is under way in cooperation with the Navy Department.

Coal and Gaseous Fuels

The committee on coal and coke announced that it is planning to prepare a method of test for dustiness of coal and coke. It is desirable, according to the report, to have a standard test method to determine the efficiency of treating coal and coke with chemical and oil compounds to allay dust and give a clean fuel.

An extension of a procedure to determine volatile matter of sub-bituminous coal, lignite, and peat contained in the standard methods of analysis (D 271-33; K18-1933) has been published as tentative for use with certain low-temperature cokes, chars, anthracites, and semi-anthracites. Further study is being given to the suitability of different furnaces for the determination of coal-ash fusibility, the procedure for which is also given in this standard. To supplement the present standard procedure (a hand method) for cutting down coal samples given in the standard method of sampling coal (D 21-16; ASA XI-1921), the committee has recommended a more rapid and less expensive mechanical method.

The report of Committee D-3 on Gaseous Fuels, which was organized during the year, outlined in detail the objectives and scope of its various committees. It is the committee's recommendation and understanding that its activities are to be limited to commercially available fuel gases combustible in air. This scope not only covers all of the various types of generally classified city gases but practically all of the so-called bottled gases as well. Although these activities are to be limited to laboratory procedures, there is no doubt that they will affect, indirectly at least, commercial practices employed in the measurement, determination of quality, and the sale of common types of fuel gases. As such, they should prove of interest and benefit to industries distributing such products and particularly those portions of the American public—now representing approximately half of the population of the entire United States—using gaseous fuels.

Water—Particularly Boiler Feed Water

Committee D-19 on Water for Industrial Uses reported progress stating that it expects to issue for information later in the year proposed standard methods for the determination of sulfate, hydroxide, total carbon dioxide, and total orthophosphate ions—these being based on research work completed by the Boiler Feed Waters Committee. Active work is under way to establish standard methods of analysis of the chloride, calcium, and magnesium ions.

Committee reports were preprinted by the American Society for Testing Materials, and copies of these preprints are available from the A.S.T.M., 260 South Broad Street, Philadelphia.

All approved A.S.T.M. standards will be published by the Society this fall in its triennial *Book of A.S.T.M. Standards*, issued in two volumes. The tentative standards of the Society will be published separately.

What is Cast Iron?

The difficulties in the way of a satisfactory answer to this famous question are so great that it has remained a moot question for a generation.

The Metallurgical Advisory Committee of the National Bureau of Standards now has under consideration the following tentative definition:

> **"Cast iron is a cast alloy of iron and carbon, with or without other elements, in which the carbon content exceeds the maximum limit of solid solubility, as determined at any temperature (which in plain cast iron is 1.7 percent) and, hence, contains eutectic carbide or praphite as a structural feature. It is not usefully forgeable at any temperature."**

This proposed definition follows along somewhat the same line as that recently suggested by the British Cast Iron Research Association, and the committee on cast iron of the American Foundrymen's Association.

New Standard Will Govern Tests Of Enclosed Electrical Switches

A new standard for enclosed electrical switches has been issued and published by the Underwriters' Laboratories. The new standard becomes effective on January 1, 1937. It was prepared by the Laboratories, and has been reviewed by and discussed with the industry as a whole, and the Laboratories' Electrical Council.

Until the standard becomes effective, a manufacturer submitting enclosed switches to the Laboratories may have the product judged under the new standard or under the requirements of the preceding edition, that of October, 1930.

Copies of the standard are available from the Underwriters' Laboratories, 207 East Ohio Street, Chicago, Ill., or from their New York and San Francisco branch offices.

Hosiery Feet Sizes Added In Commercial Standard

An addition to the Commercial Standard on Hosiery Lengths to include sizes and methods of measuring hosiery feet has been accepted by industry and is now included in the standard, according to an announcement from the Division of Trade Standards, National Bureau of Standards.

The revised standard, identified as Hosiery Lengths and Sizes CS46-36, is effective from July 20.

Mimeographed copies of the revision may be obtained from the Division of Trade Standards, National Bureau of Standards, Washington, D. C.

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